United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Minnesota Agricultural
Experiment Station

Soil Survey of Chisago County, Minnesota

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How To Use This Soil Survey

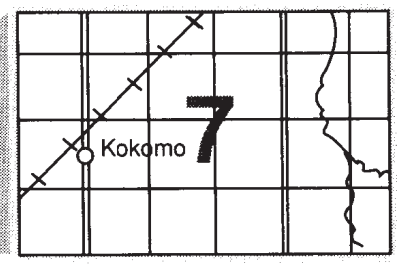
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

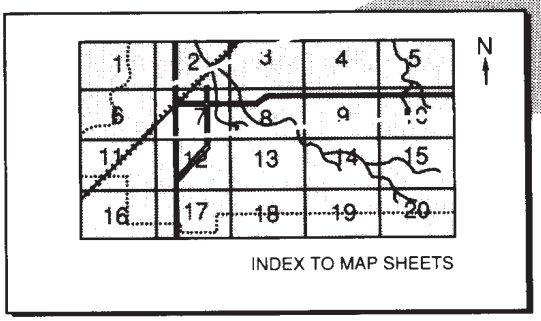
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



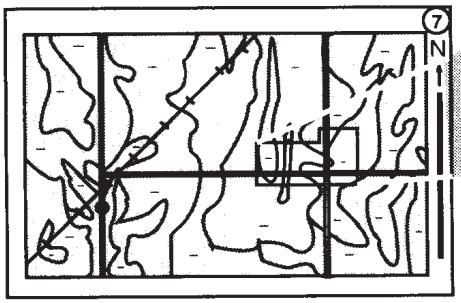
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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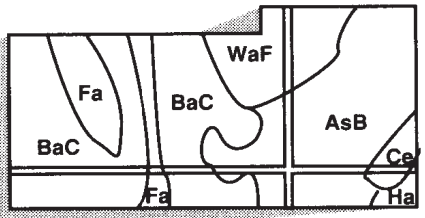

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1989. Soil names and descriptions were approved in 1990. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1989. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. Assistance was provided by the Agricultural Extension Service, Minnesota Department of Natural Resources, and the Board of Water and Soil Resources. The survey was partially funded by the Legislative Commission on Minnesota Resources and by Chisago County. It is part of the technical assistance furnished to the Chisago County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: An area of Plainbo-Rock outcrop complex, 12 to 40 percent slopes, along the St. Croix River. The river is the boundary between Minnesota and Wisconsin.

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Foreword

This soil survey contains information that can be used in land-planning programs in Chisago County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations that affect various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Gary R. Nordstrom
State Conservationist
Soil Conservation Service

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Soil Survey of Chisago County, Minnesota

By Robert W. Anderson, Soil Conservation Service

Fieldwork by Robert W. Anderson and Raymond C. Genrich, Soil Conservation Service, and Richard W. Diers, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Minnesota Agricultural Experiment Station

CHISAGO COUNTY is in east-central Minnesota on the Wisconsin border (fig. 1). It has a total area of 265,200 acres. In 1980, the population of the county was 25,717. Center City, the county seat, had a population of 1,972.

About 61 percent of Chisago County is used as cropland or pasture. About 27 percent is woodland, and 12 percent is urban land or idle land.

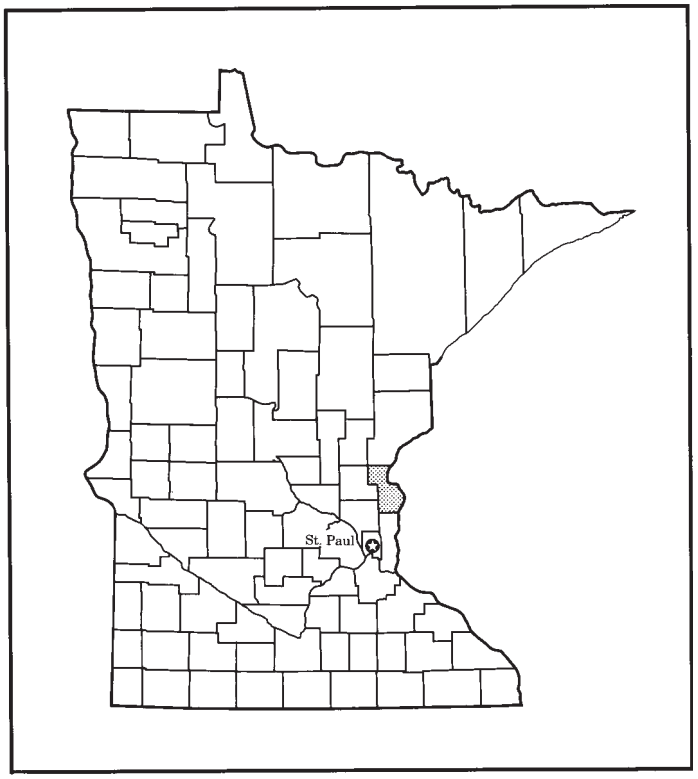

Figure 1.—Location of Chisago County in Minnesota.

General Nature of the County

This section provides general information concerning Chisago County. It describes physiography, relief, and drainage; history; and climate.

Physiography, Relief, and Drainage

The varied impact of glacial movement through the survey area has resulted in a diverse land surface. The direction of major glacial advance was from west to east. As the glaciers retreated to the west, the glacial meltwater tended to flow toward the east. This drainage pattern continues to the present time, and most surface drainage flows toward the St. Croix River. A few drainageways in the county, such as the Sunrise River, flow toward the north. The Sunrise River originally flowed south as an overflow channel from the St. Croix River, during the period when Glacial Lake Duluth was draining *(9)*.

Two major rivers run through Chisago County. The St. Croix River is the largest river in the region. It flows from north to south and serves as the eastern boundary of the county and the state. The Sunrise River flows

into the St. Croix River. Other streams or creeks flow into these two rivers. The Sunrise River has four branches—the West Branch, near Stacy; the South Branch, near the community of Wyoming; the North Branch, in the community of North Branch; and Hay Creek, northeast of North Branch. Lakes around Lindstrom, in the southeastern part of the county, have underground flow to the southwest and west, toward the South Branch of the Sunrise River. Tributaries of the St. Croix River in the northern part of the county are Rock, Rush, and Goose Creeks, which drain lakes in the northwestern part of the county, and Dry Creek, which is near Taylors Falls in the southern part.

Generally, the landscape in the survey area is gently sloping. Local relief ranges from 20 to 40 feet. The county can be divided into four major landscape regions. The northwestern and southeastern parts of the county are predominantly gently undulating glacial till plains, but some areas are more sloping. Most of the county's lakes are in these regions. Elevation is about 920 to 980 feet above sea level, but a few areas are about 1,000 feet above sea level. Most of the deep lakes in these regions are 20 to 40 feet deep, but some, such as South Center Lake, are about 100 feet deep. The shallower lakes average less than 20 feet in depth.

The central region of the county, which is part of the Anoka Sand Plain, is generally nearly level. It is approximately 840 to 900 feet above sea level.

The fourth region bounds the first three regions on the east and parallels the St. Croix River. This region has a wide variety of landforms, including bogs, flood plains, and outwash plains. The slope in this region ranges from level to steep. Elevation ranges from approximately 850 feet above sea level in the north to 700 feet above sea level in the south. The southeastern edge of this region, along the St. Croix River, has the steepest slopes, and bedrock is exposed in some areas. This region has a sharp elevation break averaging 40 to 50 feet that separates the uplands from the old St. Croix River Valley.

History

The original inhabitants of the survey area, in about 1000 B.C., were Mound Builders. Much later the Dakota inhabited the area, but they were eventually replaced by the Chippewa. Chisago County, which was organized in 1851, derived its name from the word "Ki-chi-saga," which the Chippewa used to describe the area north of Center City as "fair and lovely waters" *(5)*. Center City, which was established during the 1850's, was the first permanent Swedish settlement in Minnesota *(3)*.

Taylors Falls was the site of a French fort from 1700 to 1703. Two occurrences helped to make Taylors Falls the leading trade center in the area. The first was a treaty with the Chippewa in 1837. In accordance with this treaty, the Chippewa moved away from the area, which resulted in an influx of settlers; also, Taylors Falls became a stop-over for settlers traveling to the farming regions farther west. The second occurrence was in 1881, when the Northern Pacific Railway bypassed the lumbering community of Franconia, which further increased traffic through Taylors Falls.

Most of the immigrants to the area came from Sweden. The town of Lindstrom remains a center of this heritage.

In 1890, lumbering was such a large industry in the area that Nevers Dam was built to control logjams on the St. Croix River. The dam was the largest wooden-pile dam in the world.

As the lumbering industry declined, around 1914, more cleared land was used for agriculture. Potatoes were a major crop, especially in the western half of the county. During this period and until about 1930, North Branch was the center of the Potato Belt.

Agriculture is still a dominant land use in the county, but because of industrial growth and the proximity to the Twin Cities metropolitan area, urban development has increased. The development of major highways throughout the county has contributed to this growth. Most of the urban expansion has taken place along these corridors *(3, 4, 5)*.

Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at Cambridge, Minnesota, in the period 1951 to 1984. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 13 degrees F and the average daily minimum temperature is 3 degrees. The lowest temperature on record, which occurred at Cambridge on January 9, 1977, is -41 degrees. In summer, the average temperature is 68 degrees and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred at Cambridge on June 30, 1963, is 100 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 29 inches. Of this, about 22 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 12 inches. The heaviest 1-day rainfall during the period of record was 5.47 inches on July 22, 1972. Thunderstorms occur on about 38 days each year, and most occur in June.

The average seasonal snowfall is 45 inches. The greatest snow depth at any one time during the period of record was about 45 inches. On the average, 110 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the

significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The soil names and boundaries in this survey may not fully agree with those in the surveys of adjacent areas. Differences are the result of changes in series concepts or of variations in slope groupings.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Cushing-Talmoon Association

Nearly level to very steep, well drained and poorly drained, loamy soils that formed in glacial till; on uplands

Setting

Landform and position on the landform: Knolls, summits, side slopes, and drainageways on ground moraines (fig. 2)
Slope range: 0 to 35 percent

Composition

Percent of survey area: 17
Extent of components in the association:
Cushing soils and similar soils—45 percent
Talmoon soils and similar soils—20 percent
Minor soils—35 percent

Soil Properties and Qualities

Cushing

Drainage class: Well drained
Parent material: Glacial till
Surface texture: Loam

Talmoon

Drainage class: Poorly drained
Parent material: Glacial till
Surface texture: Loam

Minor Soils

- The very poorly drained Bluffton and Cathro soils in depressions
- The somewhat poorly drained Alstad soils in level areas and swales
- The well drained Braham soils on side slopes
- The well drained Fairport and excessively drained Plainbo soils on side slopes along the St. Croix River near Taylors Falls
- The excessively drained Mahtomedi soils on summits and shoulder slopes

Use and Management

Major uses: Cropland, hayland, and pasture
Major management factors: Cushing—water erosion, slope; Talmoon—wetness

2. Alstad-Talmoon Association

Nearly level and gently undulating, somewhat poorly drained and poorly drained, loamy soils that formed in glacial till; on uplands

Setting

Landform and position on the landform: Low rises, level areas, and drainageways on ground moraines (fig. 3)
Slope range: 0 to 3 percent

Composition

Percent of survey area: 6
Extent of components in the association:
Alstad soils and similar soils—50 percent
Talmoon soils and similar soils—25 percent
Minor soils—25 percent

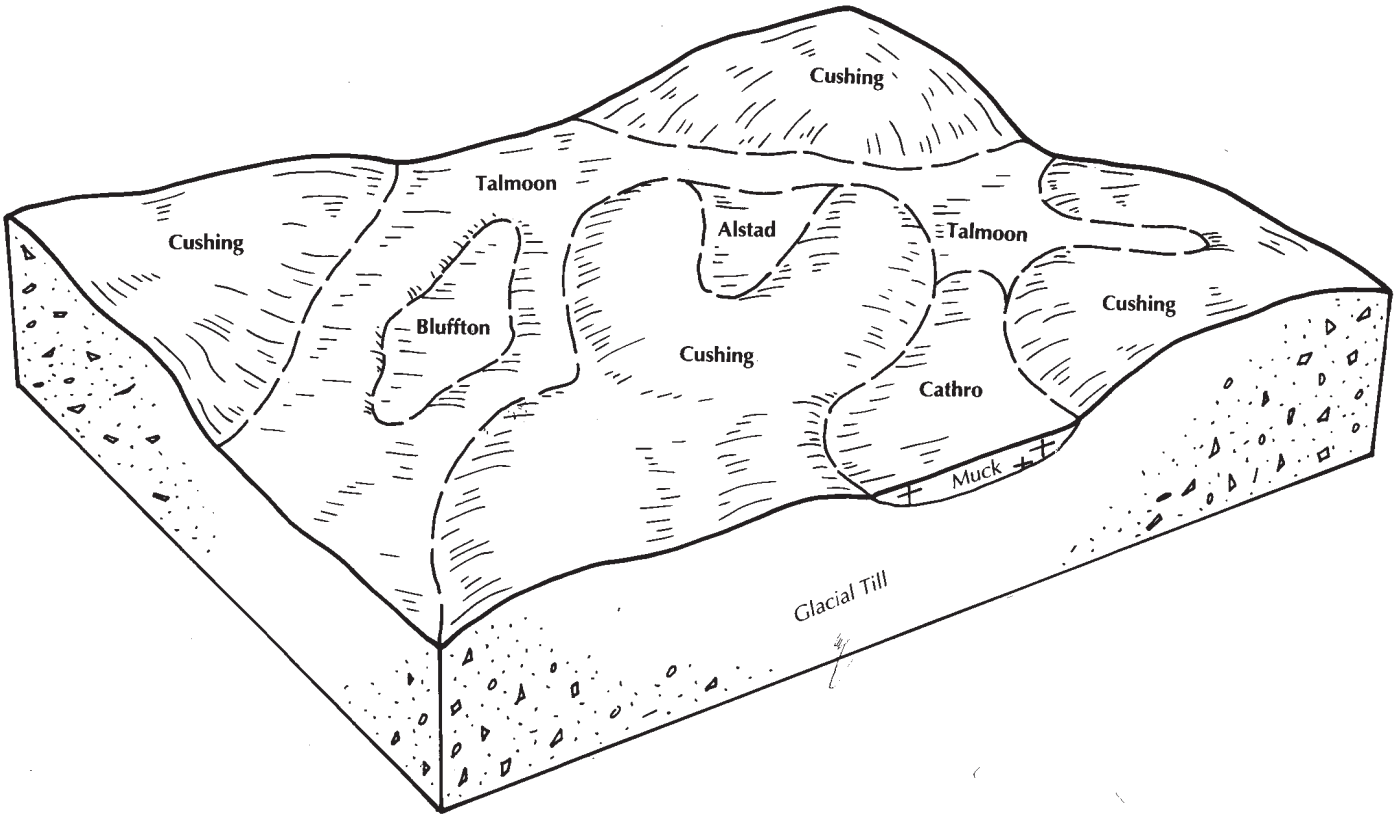

Figure 2.—Pattern of soils and parent material in the Cushing-Talmoon association.

Soil Properties and Qualities

Alstad

Drainage class: Somewhat poorly drained
Parent material: Glacial till
Surface texture: Loam

Talmoon

Drainage class: Poorly drained
Parent material: Glacial till
Surface texture: Loam

Minor Soils

- The very poorly drained Bluffton and Cathro soils in depressions
- The well drained Cushing soils on knolls and ridges
- The poorly drained Blomford soils in swales
- The moderately well drained Eckvoll soils on slight rises

Use and Management

Major uses: Cropland, hayland, and pasture

Major management factors: Alstad—no limitations; Talmoon—wetness

3. Nebish-Talmoon Association

Nearly level to very steep, well drained and poorly drained, loamy soils that formed in glacial till; on uplands

Setting

Landform and position on the landform: Knolls, summits, side slopes, and drainageways on ground moraines
Slope range: 0 to 40 percent

Composition

Percent of survey area: 22
Extent of components in the association:
Nebish soils and similar soils—50 percent
Talmoon soils and similar soils—25 percent
Minor soils—25 percent

Soil Properties and Qualities

Nebish

Drainage class: Well drained
Parent material: Glacial till
Surface texture: Loam

Talmoon

Drainage class: Poorly drained
Parent material: Glacial till
Surface texture: Loam

Minor Soils

- The very poorly drained Bluffton and Cathro soils in depressions
- The somewhat poorly drained and moderately well drained Beltrami soils in level areas and on slight rises
- The well drained Braham soils on side slopes
- The well drained Fairport and excessively drained Plainbo soils on side slopes and escarpments along the St. Croix River

Use and Management

Major uses: Cropland, hayland, and pasture
Major management factors: Nebish—water erosion, slope; Talmoon—wetness

4. Beltrami-Talmoon Association

Nearly level and gently undulating, moderately well drained, somewhat poorly drained, and poorly drained, loamy soils that formed in glacial till; on uplands

Setting

Landform and position on the landform: Low rises, level areas, and drainageways on ground moraines
Slope range: 0 to 3 percent

Composition

Percent of survey area: 7

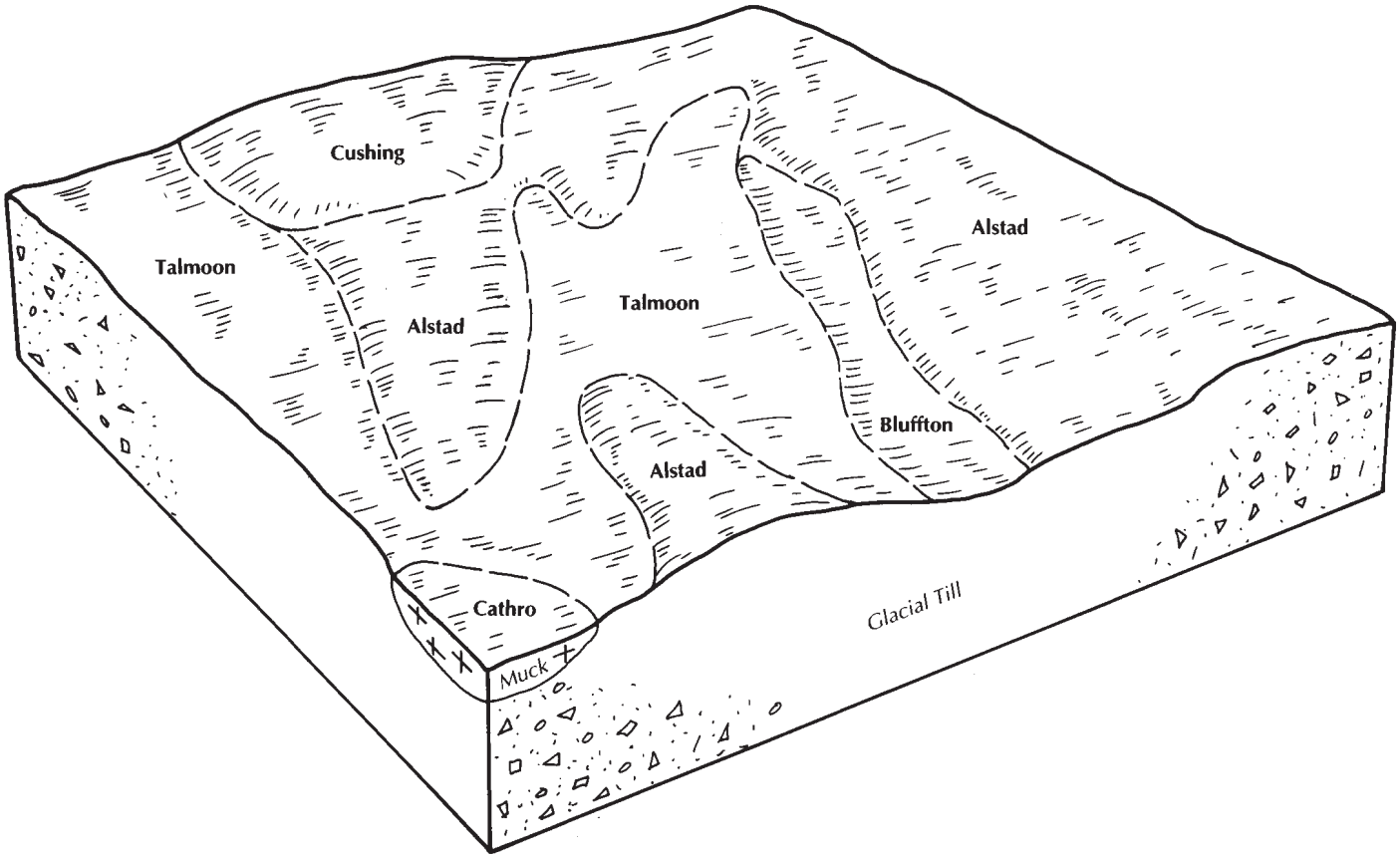

Figure 3.—Pattern of soils and parent material in the Alstad-Talmoon association.

Extent of components in the association:
Beltrami soils and similar soils—40 percent
Talmoon soils and similar soils—30 percent
Minor soils—30 percent

Soil Properties and Qualities

Beltrami

Drainage class: Somewhat poorly drained and moderately well drained
Parent material: Glacial till
Surface texture: Loam

Talmoon

Drainage class: Poorly drained
Parent material: Glacial till
Surface texture: Loam

Minor Soils

- The very poorly drained Bluffton and Cathro soils in depressions
- The well drained Nebish soils on knolls
- The poorly drained Blomford soils in swales
- The moderately well drained Eckvoll soils on slight rises

Use and Management

Major uses: Cropland, hayland, and pasture
Major management factors: Beltrami—no limitations; Talmoon—wetness

5. Braham-Blomford-Eckvoll Association

Nearly level to rolling, well drained, poorly drained, and moderately well drained, sandy soils that formed in glacial outwash and the underlying glacial till; on uplands

Setting

Landform and position on the landform: Knolls, summits, side slopes, foot slopes, and drainageways on ground moraines
Slope range: 0 to 12 percent

Composition

Percent of survey area: 4
Extent of components in the association:
Braham soils and similar soils—35 percent
Blomford soils and similar soils—25 percent
Eckvoll soils and similar soils—15 percent
Minor soils—25 percent

Soil Properties and Qualities

Braham

Drainage class: Well drained
Parent material: Glacial outwash and the underlying loamy glacial till
Surface texture: Loamy fine sand

Blomford

Drainage class: Poorly drained
Parent material: Glacial outwash and the underlying lacustrine sediments
Surface texture: Loamy sand

Eckvoll

Drainage class: Moderately well drained
Parent material: Glacial outwash and the underlying loamy glacial till
Surface texture: Loamy sand

Minor Soils

- The very poorly drained Kratka soils in depressions
- The well drained Cushing soils on knolls, summits, and side slopes
- The excessively drained Mahtomedi soils on ridges and knolls
- The somewhat poorly drained Alstad soils on slight rises
- The poorly drained Talmoon soils in swales

Use and Management

Major uses: Cropland, hayland, and pasture
Major management factors: Braham—droughtiness, wind erosion, and water erosion; Blomford—wetness; Eckvoll—droughtiness and wind erosion

6. Milaca-Ronneby Association

Nearly level to steep, well drained and somewhat poorly drained, loamy soils that formed in glacial till; on uplands

Setting

Landform and position on the landform: Knolls, summits, side slopes, shoulder slopes, low rises, and drainageways on ground moraines
Slope range: 0 to 25 percent

Composition

Percent of survey area: 2
Extent of components in the association:
Milaca soils and similar soils—40 percent
Ronneby soils and similar soils—25 percent
Minor soils—35 percent

Soil Properties and Qualities

Milaca

Drainage class: Well drained

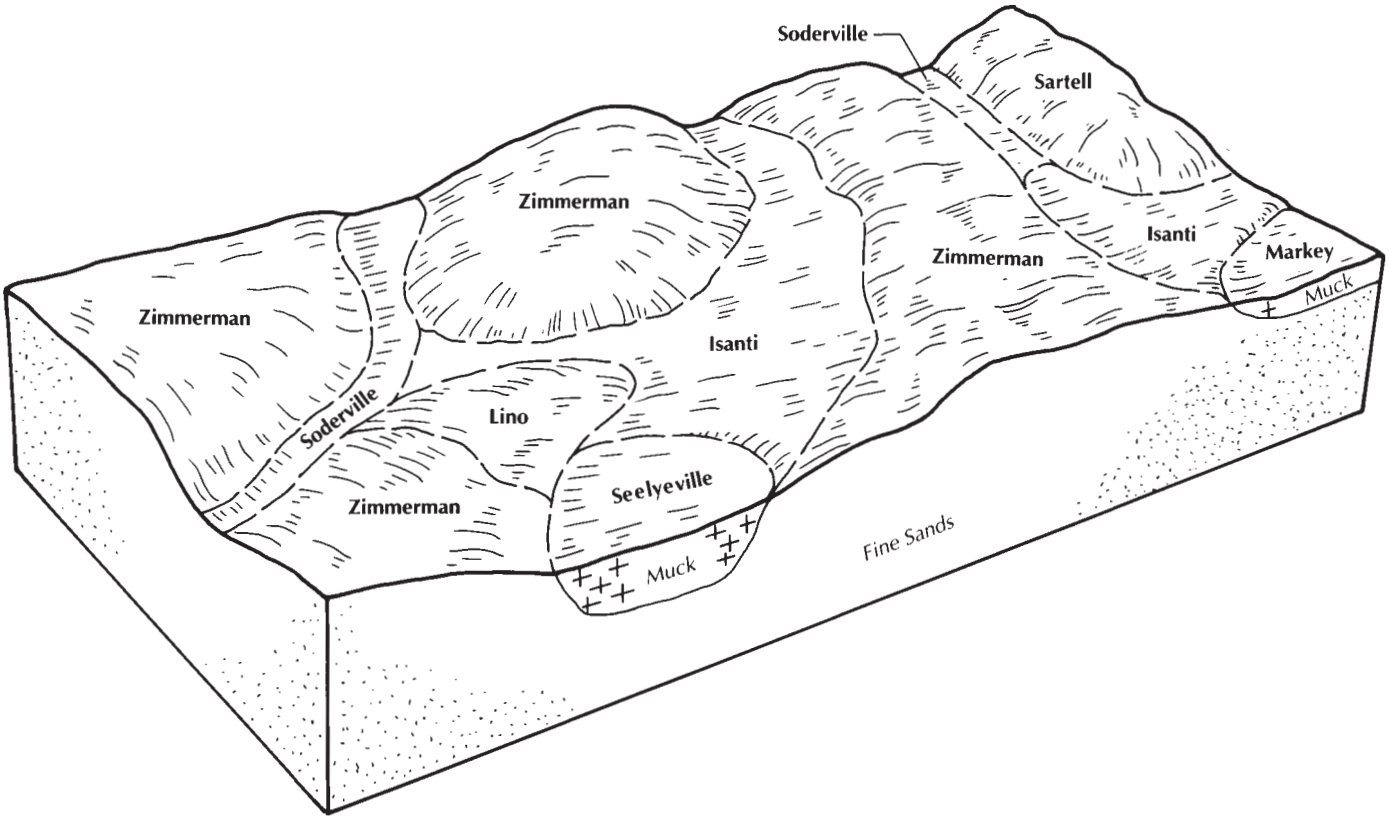

Figure 4.—Pattern of soils and parent material in the Zimmerman-Isanti association.

Parent material: Loamy glacial till
Surface texture: Sandy loam

Ronneby

Drainage class: Somewhat poorly drained
Parent material: Loamy glacial till
Surface texture: Loam

Minor Soils

• The very poorly drained Prebish, Cathro, and Seelyeville soils in depressions
• The poorly drained Siren soils on low rises
• The moderately well drained Mora soils in level areas and on slight rises
• The excessively drained Mahtomedi soils on ridges and knolls

Use and Management

Major uses: Pasture, woodland, recreation
Major management factors: Milaca—surface stones, water erosion, slope; Ronneby—surface stones, wetness

7. Zimmerman-Isanti Association

Nearly level to rolling, excessively drained and very poorly drained, sandy soils that formed in glacial outwash, eolian sediment, or both; on uplands

Setting

Landform and position on the landform: Knolls, summits, side slopes, shallow depressions, and drainageways on outwash plains (fig. 4)
Slope range: 0 to 12 percent

Composition

Percent of survey area: 21
Extent of components in the association:
Zimmerman soils and similar soils—40 percent
Isanti soils and similar soils—25 percent
Minor soils—35 percent

Soil Properties and Qualities

Zimmerman

Drainage class: Excessively drained

Parent material: Glacial outwash, eolian sediment, or both
Surface texture: Loamy fine sand

Isanti

Drainage class: Very poorly drained
Parent material: Glacial outwash
Surface texture: Loamy fine sand

Minor Soils

• The very poorly drained Markey and Seelyeville soils in depressions
• The somewhat poorly drained Lino and Soderville soils on foot slopes and in swales
• The excessively drained Sartell soils on summits and side slopes
• The moderately well drained Eckvoll soils on slight rises

Use and Management

Major uses: Cropland, hayland, and pasture
Major management factors: Zimmerman—droughtiness, wind erosion, and water erosion; Isanti—wetness

8. Mahtomedi-Pomroy Association

Nearly level to very steep, excessively drained and well drained, sandy soils that formed in glacial outwash or in glacial outwash and the underlying glacial till; on uplands

Setting

Landform and position on the landform: Knolls, summits, side slopes, and shoulder slopes on uplands
Slope range: 1 to 35 percent

Composition

Percent of survey area: 4
Extent of components in the association:
Mahtomedi soils and similar soils—40 percent
Pomroy soils and similar soils—25 percent
Minor soils—35 percent

Soil Properties and Qualities

Mahtomedi

Drainage class: Excessively drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Pomroy

Drainage class: Well drained
Parent material: Glacial outwash and the underlying loamy glacial till
Surface texture: Loamy fine sand

Minor Soils

• The very poorly drained Warman, Markey, and Seelyeville soils in depressions
• The well drained Milaca soils on summits, knolls, and side slopes
• The excessively drained Nymore soils on summits and side slopes

Use and Management

Major uses: Pasture, hayland, and cropland
Major management factors: Droughtiness, wind erosion, and water erosion

9. Nymore-Lino Association

Nearly level to steep, excessively drained and somewhat poorly drained, sandy soils that formed in glacial outwash; on uplands

Setting

Landform and position on the landform: Shoulder slopes, knolls, side slopes, low rises, and drainageways on outwash plains
Slope range: 0 to 25 percent

Composition

Percent of survey area: 7
Extent of components in the association:
Nymore soils and similar soils—45 percent
Lino soils and similar soils—20 percent
Minor soils—35 percent

Soil Properties and Qualities

Nymore

Drainage class: Excessively drained
Parent material: Glacial outwash
Surface texture: Loamy sand

Lino

Drainage class: Somewhat poorly drained
Parent material: Glacial outwash
Surface texture: Loamy fine sand

Minor Soils

• The very poorly drained Newson and Warman soils in depressions and drainageways
• The somewhat excessively drained Chetek soils on summits and side slopes
• The well drained Pomroy soils on side slopes and ridges

Use and Management

Major uses: Pasture, hayland, woodland, cropland, and recreation

Major management factors: Nymore—droughtiness and wind erosion; Lino—wetness and wind erosion

10. Seelyeville-Markey Association

Nearly level, very poorly drained soils that formed in organic deposits and in organic deposits overlying glacial outwash; on uplands

Setting

Landform and position on the landform: Depressions on ground moraines and outwash plains
Slope range: 0 to 1 percent

Composition

Percent of survey area: 8
Extent of components in the association:
Seelyeville soils and similar soils—60 percent
Markey soils and similar soils—20 percent
Minor soils—20 percent

Soil Properties and Qualities

Seelyeville

Drainage class: Very poorly drained
Parent material: Herbaceous plant material
Surface texture: Muck

Markey

Drainage class: Very poorly drained
Parent material: Herbaceous plant material overlying sandy glacial outwash
Surface texture: Muck

Minor Soils

• The very poorly drained Kratka and Cathro soils in depressions
• The somewhat poorly drained Lino soils on low rises
• The poorly drained Talmoon soils on rims of depressions

Use and Management

Major uses: Specialty crops, cultured sod, pasture, and wildlife habitat
Major management factors: Wetness and wind erosion

11. Fordum-Caryville Association

Nearly level, very poorly drained, poorly drained, and moderately well drained, loamy and sandy soils that formed in alluvial deposits; on flood plains

Setting

Landform and position on the landform: Low rises, swales, and channels on flood plains
Slope range: 0 to 2 percent

Composition

Percent of survey area: 2
Extent of components in the association:
Fordum soils and similar soils—40 percent
Caryville soils and similar soils—25 percent
Minor soils—35 percent

Soil Properties and Qualities

Fordum

Drainage class: Poorly drained and very poorly drained
Parent material: Alluvial sediment
Surface texture: Sandy loam

Caryville

Drainage class: Moderately well drained
Parent material: Alluvial sediment
Surface texture: Sandy loam

Minor Soils

• The very poorly drained Seelyeville and Markey soils in depressions
• The excessively drained Nymore soils on side slopes

Use and Management

Major uses: Wildlife habitat, pasture, and woodland
Major management factors: Fordum—flooding, wetness; Caryville—flooding, droughtiness

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Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under the heading "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Cushing loam, 2 to 6 percent slopes, is a phase of the Cushing series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Mahtomedi-Cushing complex, 2 to 6 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The Pits, gravel, component of the Udorthents-Pits, gravel, complex is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils.

Soil Descriptions

40B—Nebish loam, 2 to 6 percent slopes

Composition

Nebish soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines (fig. 5)
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 10 inches—dark grayish brown loam
10 to 21 inches—dark yellowish brown clay loam
21 to 40 inches—yellowish brown loam
40 to 60 inches—yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate

Figure 5.—An area of Nebish loam, 2 to 6 percent slopes. Homesite development is increasing in areas of this soil.

Available water capacity: High
Organic matter content: Moderately low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained and somewhat poorly drained Beltrami soils, which are on foot slopes and low rises and in swales
• The very poorly drained Bluffton soils, which are in depressions
• The well drained Braham soils, which are on side slopes and knolls and have a sandy mantle 20 to 40 inches deep over loamy glacial till
• The poorly drained Talmoon soils, which are in drainageways

Similar soils:
• Soils that have a redder hue and more clay
• Soils that have more silt in the upper part of the profile
• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam

Use and Management

Cropland

Major management factor: Water erosion

• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

Interpretive Groups

Land capability classification: 2e
Windbreak suitability group: 3

40C—Nebish loam, 6 to 12 percent slopes

Composition

Nebish soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 8 inches—very dark grayish brown loam
8 to 33 inches—dark yellowish brown clay loam
33 to 60 inches—dark yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderately low
Surface runoff: Medium or rapid
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The moderately well drained and somewhat poorly drained Beltrami soils, which are on foot slopes and in swales
• The very poorly drained Bluffton soils, which are in depressions
• The well drained Braham soils, which are on side slopes and knolls and have a sandy mantle 20 to 40 inches deep over loamy glacial till
• The poorly drained Talmoon soils, which are in drainageways

Similar soils:
• Soils that have a redder hue and more clay
• Soils that have more silt in the upper part of the profile
• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam

Use and Management

Cropland

Major management factor: Water erosion
• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

Interpretive Groups

Land capability classification: 3e
Windbreak suitability group: 3

40D—Nebish loam, 12 to 25 percent slopes

Composition

Nebish soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 7 inches—dark brown loam
7 to 14 inches—dark yellowish brown clay loam
14 to 42 inches—dark yellowish brown loam
42 to 60 inches—yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderately low
Surface runoff: Rapid
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton soils, which are in depressions
• The well drained Braham soils, which are on side slopes and have a sandy mantle 20 to 40 inches deep over loamy glacial till
• The poorly drained Talmoon soils, which are in drainageways

Similar soils:
• Soils that have a redder hue and more clay
• Soils that have more silt in the upper part of the profile
• Soils that are shallower to free carbonates
• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the slope

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• The slope limits some management practices and increases the hazard of erosion.

Interpretive Groups

Land capability classification: 6e
Windbreak suitability group: 3

40F—Nebish loam, 25 to 40 percent slopes

Composition

Nebish soil and similar soils: 90 to 98 percent
Contrasting inclusions: 2 to 10 percent

Setting

Landform and position on the landform: Side slopes and shoulder slopes on ground moraines
Shape of areas: Somewhat elongated or irregular
Size of areas: 3 to 60 acres

Typical Profile

0 to 4 inches—very dark grayish brown loam
4 to 6 inches—brown fine sandy loam
6 to 22 inches—dark yellowish brown clay loam
22 to 36 inches—dark yellowish brown sandy clay loam
36 to 60 inches—yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderately low
Surface runoff: Very rapid
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:

• The very poorly drained Bluffton soils, which are in depressions

• The well drained Fairport and excessively drained Plainbo soils, which are on side slopes and escarpments along the St. Croix River and have bedrock at a depth of 20 to 40 inches

• The poorly drained Talmoon soils, which are in drainageways

Similar soils:

• Soils that have a redder hue and more clay

• Soils that have more silt in the upper part of the profile

• Soils that are shallower to free carbonates

• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the slope

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and the slope

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• The slope limits some management practices and increases the hazard of erosion.

Interpretive Groups

Land capability classification: 7e
Windbreak suitability group: 3

75—Bluffton loam

Composition

Bluffton soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Shallow depressions and drainageways on ground moraines
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 19 inches—black loam
19 to 40 inches—olive gray, mottled loam
40 to 60 inches—olive gray, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid in the upper part, moderately slow in the lower part
Available water capacity: High
Organic matter content: Moderate or high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:

• The very poorly drained Cathro soils, which are in depressions and have muck overlying loamy glacial till

• The poorly drained Talmoon soils, which are in swales and on the borders of depressions

Similar soils:
• Soils that have a surface layer of muck as much as 16 inches thick
• Soils that have layers of sand and gravel in the subsoil
• Soils that have a surface layer of silt loam or sandy clay loam

Use and Management

Cropland

Major management factors: Wetness and compaction
• The major crops are corn, soybeans, and small grain.
• A drainage system is needed for optimum crop production.
• If the soil is worked when it is too wet, it becomes compacted and forms clods.

Pasture and forage

Major management factors: Overgrazing, weed control, compaction, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Grazing only during dry periods minimizes surface compaction.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—3w; undrained—6w
Windbreak suitability group: Drained—2W; undrained—10

119B—Pomroy loamy fine sand, 1 to 6 percent slopes

Composition

Pomroy soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 9 inches—very dark grayish brown loamy fine sand
9 to 20 inches—dark brown loamy fine sand
20 to 40 inches—reddish brown, mottled sandy loam
40 to 60 inches—reddish brown sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Rapid in the upper part, slow or very slow in the lower part
Available water capacity: Low
Organic matter content: Low
Surface runoff: Slow
Depth to the water table: More than 6 feet
Special characteristics: The underlying dense till, which restricts root penetration and may perch water for brief periods

Inclusions

Contrasting inclusions:
• The well drained Milaca soils, which are in landscape positions similar to those of the Pomroy soil and do not have a sandy mantle
• The very poorly drained Newson soils, which are in drainageways and depressions

Similar soils:
• Soils that have finer textures in the underlying material
• Soils that have a thicker sandy mantle
• Soils in swales or level areas that are moderately well drained
• Soils that have a surface layer of fine sand, loamy sand, or sand

Use and Management

Cropland

Major management factors: Droughtiness, water erosion, and wind erosion
• The major crops are corn, small grain, and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling

weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 3s
Windbreak suitability group: 5

119C—Pomroy loamy fine sand, 6 to 12 percent slopes

Composition

Pomroy soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits, knolls, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 5 inches—very dark brown loamy fine sand
5 to 25 inches—brown loamy fine sand
25 to 45 inches—reddish brown sandy loam
45 to 60 inches—dark reddish brown and reddish brown sandy loam and fine sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Rapid in the upper part, slow or very slow in the lower part
Available water capacity: Low
Organic matter content: Low
Surface runoff: Medium
Depth to the water table: More than 6 feet
Special characteristics: The underlying dense till, which restricts root penetration and may perch water for brief periods

Inclusions

Contrasting inclusions:
• The well drained Milaca soils, which are in landscape positions similar to those of the Pomroy soil and do not have a sandy mantle
• The very poorly drained Newson soils, which are in drainageways and depressions

Similar soils:
• Soils that have finer textures in the underlying material
• Soils that have a thicker sandy mantle
• Soils that have a surface layer of fine sand, loamy sand, or sand

Use and Management

Cropland

Major management factors: Droughtiness, wind erosion, and water erosion
• The major crops are small grain and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 5

155B—Chetek sandy loam, 1 to 6 percent slopes

Composition

Chetek soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 9 inches—black sandy loam
9 to 24 inches—dark reddish brown sandy loam
24 to 29 inches—dark brown gravelly loamy sand
29 to 60 inches—brown gravelly sand

Soil Properties and Qualities

Drainage class: Somewhat excessively drained
Permeability: Moderately rapid in the upper part, rapid and very rapid in the lower part
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The excessively drained Mahtomedi soils, which are in landscape positions similar to those of the Chetek soil and do not have a loamy mantle
• The very poorly drained Warman soils, which are in depressions and drainageways
• Soils that have loamy glacial till at a depth of less than 60 inches

Similar soils:
• Soils that have less gravel in the underlying material
• Soils that have more clay in the subsoil
• Soils that have a yellower hue in the subsoil and underlying material
• Soils that have a surface layer of loam

Use and Management

Cropland

Major management factors: Water erosion, wind erosion, and droughtiness
• The major crops are corn, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 3e
Windbreak suitability group: 7

155C—Chetek loam, 6 to 12 percent slopes

Composition

Chetek soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 4 inches—very dark gray loam
4 to 23 inches—dark brown sandy loam
23 to 60 inches—dark yellowish brown gravelly sand

Soil Properties and Qualities

Drainage class: Somewhat excessively drained
Permeability: Moderately rapid in the upper part, rapid or very rapid in the lower part
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The excessively drained Mahtomedi soils, which are in landscape positions similar to those of the Chetek soil and do not have a loamy mantle
• The very poorly drained Warman soils, which are in depressions and drainageways

Similar soils:
• Soils that have less gravel in the underlying material
• Soils that have more clay in the subsoil
• Soils that have a yellower hue in the subsoil and underlying material
• Soils that have a surface layer of sandy loam

Use and Management

Cropland

Major management factors: Water erosion, wind erosion, and droughtiness
• The major crops are small grain and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.

• Leaving crop residue on the surface reduces the hazard of wind erosion.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4e
Windbreak suitability group: 7

158B—Zimmerman loamy fine sand, 1 to 6 percent slopes

Composition

Zimmerman soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 80 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy fine sand
8 to 20 inches—dark yellowish brown fine sand
20 to 60 inches—yellowish brown fine sand that has thin bands of dark yellowish brown loamy fine sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The somewhat poorly drained Soderville soils, which are in swales

Similar soils:
• Soils that have a coarser texture or that do not have bands in the underlying material
• Soils that have a surface layer of fine sand
• Soils that have more gravel

Use and Management

Cropland

Major management factors: Droughtiness and wind erosion (fig. 6)
• The major crops are corn, soybeans, small grain, and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 7

158C—Zimmerman loamy fine sand, 6 to 12 percent slopes

Composition

Zimmerman soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits, knolls, and side slopes on outwash plains

Figure 6.—Field windbreaks help to control wind erosion in an area of Zimmerman loamy fine sand, 1 to 6 percent slopes. The Zimmerman soil is on the ridges, and Lino loamy fine sand is in the swales.

Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy fine sand
8 to 30 inches—dark yellowish brown fine sand
30 to 60 inches—yellowish brown fine sand that has thin bands of yellowish brown loamy fine sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The somewhat poorly drained Soderville soils, which are in swales

Similar soils:
• Soils that have a coarser texture or that do not have bands in the underlying material
• Soils that have a surface layer of fine sand
• Soils that have more gravel

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of excessive droughtiness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 7

159B—Anoka loamy very fine sand, 1 to 6 percent slopes

Composition

Anoka soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 9 inches—very dark grayish brown loamy very fine sand
9 to 25 inches—dark brown loamy fine sand
25 to 36 inches—dark yellowish brown fine sandy loam
36 to 51 inches—brown fine sand and dark yellowish brown loamy very fine sand
51 to 60 inches—yellowish brown fine sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: Moderate
Organic matter content: Low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The somewhat poorly drained Lino and Soderville soils, which are in swales

Similar soils:
• Soils that have bands of finer textured material
• Soils that do not have bands in the profile
• Soils that have a surface layer of fine sandy loam, very fine sand, loam, or fine sand

Use and Management

Cropland

Major management factors: Water erosion, wind erosion, and droughtiness
• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Droughtiness is a hazard during most years because of the moderate available water capacity.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 3e
Windbreak suitability group: 5

159C—Anoka loamy fine sand, 6 to 12 percent slopes

Composition

Anoka soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 20 acres

Typical Profile

0 to 6 inches—dark brown loamy fine sand
6 to 21 inches—yellowish brown fine sand
21 to 28 inches—strong brown fine sandy loam
28 to 44 inches—yellowish brown fine sand
44 to 56 inches—bands of yellowish brown fine sand and strong brown fine sandy loam
56 to 60 inches—yellowish brown fine sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: Moderate
Organic matter content: Low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The somewhat poorly drained Soderville soils, which are in swales

Similar soils:
• Soils that have bands of finer textured material
• Sandy soils that do not have bands in the profile
• Soils that have a surface layer of loamy fine sand, very fine sand, or fine sand

Use and Management

Cropland

Major management factors: Water erosion, wind erosion, and droughtiness
• The major crops are corn, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Droughtiness is a hazard during most years because of the moderate available water capacity.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4e
Windbreak suitability group: 5

161—Isanti loamy fine sand

Composition

Isanti soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Shallow depressions and drainageways on outwash plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 12 inches—black loamy fine sand
12 to 60 inches—grayish brown, mottled fine sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderate to very high
Surface runoff: Very slow or ponded
Depth to the water table: 0 to 2 feet

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Lino and Soderville soils, which are on low rises
• The very poorly drained Markey soils, which are in landscape positions similar to those of the Isanti soil

Similar soils:
• Soils that have a coarser texture

• Soils that have a surface layer of fine sand, sand, loamy sand, fine sandy loam, or sandy loam

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• The major crops are corn, soybeans, and small grain.
• A drainage system is needed for optimum crop production, but establishing a drainage system is difficult in areas that do not have suitable outlets.
• Droughtiness is a hazard because of the low available water capacity, especially in the latter part of the growing season.
• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w
Windbreak suitability group: Drained—2W; undrained—10

162—Lino loamy fine sand

Composition

Lino soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes, low rises, and drainageways on outwash plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 80 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy fine sand
8 to 24 inches—brown, mottled loamy fine sand
24 to 42 inches—yellowish brown, mottled fine sand
42 to 60 inches—brown, mottled fine sand

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low or moderately low
Surface runoff: Slow
Depth to the water table: 2 to 4 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The excessively drained Nymore, Sartell, and Zimmerman soils, which are on knolls and ridges
• The somewhat poorly drained Soderville soils, which are in landscape positions similar to those of the Lino soil

Similar soils:
• Soils that have a thicker surface layer
• Soils that have gravelly coarse sand in the underlying material
• Soils that have a surface layer of loamy sand, fine sandy loam, or fine sand

Use and Management

Cropland

Major management factor: Wetness
• The major crops are corn, soybeans, small grain, and hay.
• A drainage system is needed for optimum crop production.
• Droughtiness is a hazard because of the low available water capacity, especially in the latter part of the growing season.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: 4w
Windbreak suitability group: 1

169B—Braham loamy fine sand, 2 to 6 percent slopes

Composition

Braham soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 8 inches—very dark gray loamy fine sand
8 to 20 inches—brown loamy fine sand
20 to 41 inches—dark yellowish brown clay loam
41 to 60 inches—dark yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Rapid in the upper part, moderate or moderately slow in the lower part
Available water capacity: Moderate
Organic matter content: Low or moderately low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The poorly drained Blomford soils, which are in drainageways and swales
• The very poorly drained Kratka soils, which are in depressions

Similar soils:
• Soils that have a thinner or thicker sandy mantle
• Soils that have a surface layer of fine sand, loamy sand, or sand
• Soils that are moderately well drained and are in landscape positions similar to those of the Braham soil

Use and Management

Cropland

Major management factors: Droughtiness, wind erosion, and water erosion
• The major crops are corn, soybeans, small grain, and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 3s
Windbreak suitability group: 5

169C—Braham loamy fine sand, 6 to 12 percent slopes

Composition

Braham soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits, knolls, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 8 inches—dark brown loamy fine sand
8 to 20 inches—dark yellowish brown fine sand
20 to 55 inches—dark yellowish brown sandy clay loam and reddish brown clay loam
55 to 60 inches—yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Rapid in the upper part, moderate or moderately slow in the lower part
Available water capacity: Moderate
Organic matter content: Low or moderately low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The poorly drained Blomford soils, which are in drainageways
• The very poorly drained Kratka soils, which are in depressions

Similar soils:
• Soils that have a thinner or thicker sandy mantle
• Soils that have a surface layer of fine sand, loamy sand, or sand

• Soils in similar landscape positions that are moderately well drained

Use and Management

Cropland

Major management factors: Wind erosion, water erosion, and droughtiness

• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4e
Windbreak suitability group: 5

182—Halder sandy loam

Composition

Halder soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Broad, level areas and slight rises
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 4 to 150 acres

Typical Profile

0 to 8 inches—dark brown sandy loam
8 to 12 inches—brown, mottled sandy loam
12 to 18 inches—reddish brown and brown, mottled sandy loam
18 to 32 inches—reddish brown, mottled loam
32 to 40 inches—reddish brown, mottled loamy sand
40 to 60 inches—reddish brown, mottled, stratified sand, loamy sand, and coarse sand

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part, rapid or very rapid in the lower part
Available water capacity: Moderate
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: 1.0 to 2.5 feet

Inclusions

Contrasting inclusions:

• The well drained Novak and Nymore soils, which are on knolls and ridges
• The somewhat poorly drained Lino soils, which are in landscape positions similar to those of the Halder soil
• The very poorly drained Newson soils, which are in depressions

Similar soils:

• Soils that have a surface layer of loam, silt loam, fine sandy loam, or very fine sandy loam
• Soils that have sand or fine sand in the underlying material

Use and Management

Cropland

Major management factors: Wetness and wind erosion

• The major crops are corn, soybeans, small grain, and hay.
• A drainage system is needed for optimum crop production.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Droughtiness is a hazard because of the moderate available water capacity, especially in the latter part of the growing season.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Grazing only during dry periods minimizes surface compaction.

• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: 2w
Windbreak suitability group: 1

204B—Cushing loam, 2 to 6 percent slopes

Composition

Cushing soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 5 inches—black loam
5 to 12 inches—brown loam
12 to 24 inches—dark brown clay loam and brown loam
24 to 40 inches—dark brown clay loam
40 to 60 inches—dark brown loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part, moderately slow in the lower part
Available water capacity: High
Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Alstad soils, which are on low rises
• The very poorly drained Bluffton and Cathro soils, which are in depressions
• The well drained Braham soils, which are in landscape positions similar to those of the Cushing soil
• The poorly drained Talmoon soils, which are in drainageways

Similar soils:
• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam
• Soils that have more clay in the subsoil and the underlying material

Use and Management

Cropland

Major management factor: Water erosion

• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

Interpretive Groups

Land capability classification: 2e
Windbreak suitability group: 3

204C—Cushing loam, 6 to 12 percent slopes

Composition

Cushing soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits, knolls, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 8 inches—very dark grayish brown loam
8 to 14 inches—brown sandy loam and dark brown loam
14 to 33 inches—dark yellowish brown clay loam
33 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part, moderately slow in the lower part
Available water capacity: High
Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Alstad soils, which are in slight swales
• The very poorly drained Bluffton and Cathro soils, which are in depressions

• The well drained Braham soils, which are in landscape positions similar to those of the Cushing soil
• The poorly drained Talmoon soils, which are in drainageways

Similar soils:
• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam
• Soils that have more clay in the subsoil and the underlying material

Use and Management

Cropland

Major management factor: Water erosion
• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

Interpretive Groups

Land capability classification: 3e
Windbreak suitability group: 3

204D—Cushing loam, 12 to 20 percent slopes

Composition

Cushing soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 7 inches—dark brown loam
7 to 26 inches—dark yellowish brown clay loam
26 to 40 inches—dark brown loam
40 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part, moderately slow in the lower part
Available water capacity: High
Organic matter content: Moderately low or moderate
Surface runoff: Rapid
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton and Cathro soils, which are in depressions
• The well drained Braham soils, which are in landscape positions similar to those of the Cushing soil
• The poorly drained Talmoon soils, which are in drainageways

Similar soils:
• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam
• Soils that have more clay in the subsoil and the underlying material

Use and Management

Cropland

Major management factor: Water erosion
• The major crops are small grain and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

Interpretive Groups

Land capability classification: 4e
Windbreak suitability group: 3

204F—Cushing loam, 20 to 35 percent slopes

Composition

Cushing soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits and side slopes on ground moraines
Shape of areas: Somewhat elongated or irregular
Size of areas: 3 to 100 acres

Typical Profile

0 to 3 inches—very dark grayish brown loam
3 to 6 inches—brown loam
6 to 32 inches—dark brown clay loam
32 to 60 inches—dark brown loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part, moderately slow in the lower part
Available water capacity: High
Organic matter content: Moderately low or moderate
Surface runoff: Rapid
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton soils, which are in depressions
• The poorly drained Talmoon soils, which are in drainageways and on toe slopes

Similar soils:
• Soils that have a surface layer of sandy loam, fine sandy loam, very fine sandy loam, or silt loam
• Soils that have more clay in the subsoil and underlying material

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the slope

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and the slope
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• The slope limits some management practices and increases the hazard of erosion.

Interpretive Groups

Land capability classification: 6e
Windbreak suitability group: 3

207B—Nymore loamy sand, 1 to 6 percent slopes

Composition

Nymore soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 100 acres

Typical Profile

0 to 7 inches—dark brown loamy sand
7 to 27 inches—reddish brown loamy sand
27 to 60 inches—brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Lino soils, which are on low rises
• The very poorly drained Newson soils, which are in depressions and drainageways

Similar soils:
• Soils that have a thicker and darker surface layer
• Soils that have more gravel in the underlying material
• Soils that have a surface layer of loamy fine sand

Use and Management

Cropland

Major management factors: Droughtiness and wind erosion
• The major crops are corn, small grain, and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 7

207C—Nymore loamy sand, 6 to 12 percent slopes

Composition

Nymore soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits, side slopes, and knolls on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 4 inches—dark brown loamy sand
4 to 15 inches—reddish brown loamy sand
15 to 60 inches—reddish brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:

• The very poorly drained Newson soils, which are in depressions and drainageways

Similar soils:

• Soils that have more gravel in the underlying material
• Soils that have a surface layer of loamy fine sand
• Soils that have a darker and thicker surface layer

Use and Management

Cropland

Major management factors: Droughtiness, wind erosion, and water erosion

• The major crops are small grain and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 7

207D—Nymore loamy sand, 12 to 18 percent slopes

Composition

Nymore soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 5 inches—dark brown loamy sand
5 to 21 inches—reddish brown loamy sand
21 to 60 inches—reddish brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Newson soils, which are in depressions and drainageways
• Well drained and moderately well drained soils that have a thick, dark surface layer; in swales and on toe slopes

Similar soils:
• Soils that have more gravel in the underlying material
• Soils that have a surface layer of loamy fine sand

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of excessive droughtiness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 7

207E—Nymore loamy sand, 18 to 25 percent slopes

Composition

Nymore soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes and shoulder slopes on outwash plains
Shape of areas: Somewhat elongated or irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 4 inches—dark brown loamy sand
4 to 18 inches—reddish brown loamy sand
18 to 60 inches—reddish brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Newson soils, which are in depressions and drainageways

Similar soils:
• Soils that have more gravel in the underlying material
• Soils that have a surface layer of loamy fine sand

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of excessive droughtiness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.
• The slope limits some management practices and increases the hazard of erosion.

Interpretive Groups

Land capability classification: 7s
Windbreak suitability group: 7

265—Soderville loamy fine sand

Composition

Soderville soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises, drainageways, and swales
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 9 inches—very dark grayish brown loamy fine sand
9 to 32 inches—dark brown, mottled fine sand
32 to 37 inches—yellowish brown, mottled loamy fine sand
37 to 45 inches—dark yellowish brown loamy sand
45 to 52 inches—brown, mottled sand
52 to 60 inches—dark yellowish brown, mottled loamy sand

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low
Surface runoff: Slow
Depth to the water table: 2 to 4 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions
• The excessively drained Zimmerman soils, which are on knolls and summits
• The moderately well drained Eckvoll soils, which are in landscape positions similar to those of the Soderville soil

Similar soils:
• Soils that have more clay in the subsoil
• Soils that have a surface layer of fine sand or fine sandy loam
• Soils that do not have an increase in the content of clay in the subsoil

Use and Management

Cropland

Major management factors: Wetness, droughtiness, and wind erosion
• The major crops are corn, soybeans, small grain, and hay.
• This soil is wet for brief periods in spring because of a perched water table.
• Droughtiness is a hazard because of a low available water capacity, especially in the latter part of the growing season.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, wetness, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Plant species that can tolerate wetness in spring and droughtiness during hot and dry periods in summer and fall should be selected.

Interpretive Groups

Land capability classification: 4w
Windbreak suitability group: 1

274—Newson mucky loamy sand

Composition

Newson soil and similar soils: 90 to 98 percent
Contrasting inclusions: 2 to 10 percent

Setting

Landform and position on the landform: Depressions and drainageways on outwash plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 8 inches—black mucky loamy sand
8 to 32 inches—dark grayish brown and grayish brown, mottled loamy sand
32 to 48 inches—dark grayish brown, mottled sand
48 to 60 inches—dark brown, mottled sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately rapid in the upper part, rapid in the lower part
Available water capacity: Low
Organic matter content: High or very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Lino soils, which are on low rises
• The very poorly drained Markey soils, which are in landscape positions similar to those of the Newson soil

Similar soils:
• Soils that have a surface layer of mucky sand, loamy sand, sand, fine sand, or sandy loam

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• The major crops are corn, soybeans, and small grain.
• A drainage system is needed for optimum crop production, but establishing a drainage system is difficult in areas that do not have suitable outlets.
• Droughtiness is a hazard because of the low available

water capacity, especially in the latter part of the growing season.
• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Deferring grazing during wet periods minimizes the formation of hummocks.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w
Windbreak suitability group: Drained—2W; undrained—10

292—Alstad loam

Composition

Alstad soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises, level areas, and swales on ground moraines
Slope range: 1 to 3 percent
Shape of areas: Irregular
Size of areas: 3 to 80 acres

Typical Profile

0 to 9 inches—very dark grayish brown loam
9 to 13 inches—brown, mottled loam
13 to 25 inches—yellowish brown and brown, mottled loam
25 to 39 inches—dark yellowish brown, mottled clay loam
39 to 60 inches—dark yellowish brown, mottled loam

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part, moderately slow in the lower part
Available water capacity: High
Organic matter content: Moderate
Surface runoff: Slow
Depth to the water table: 2 to 4 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton soils, which are in depressions
• The well drained Cushing soils, which are on summits and side slopes
• The moderately well drained Eckvoll soils, which are in landscape positions similar to those of the Alstad soil

Similar soils:
• Soils that are moderately well drained
• Soils that have a surface layer of sandy loam, fine sandy loam, or silt loam
• Soils that are poorly drained

Use and Management

Cropland

Major management factors: Well suited to intensive cultivation
• The major crops are corn, soybeans, small grain, and hay (fig. 7).
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

Interpretive Groups

Land capability classification: 1
Windbreak suitability group: 1

325—Prebish sandy loam

Composition

Prebish soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Depressions and drainageways on ground moraines
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 10 inches—black sandy loam
10 to 18 inches—dark grayish brown, mottled sandy loam

Figure 7.—Hay production in an area of Alstad loam. This soil is among the most productive in the county.

18 to 50 inches—reddish brown, mottled sandy loam
50 to 60 inches—reddish brown sandy loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately rapid to moderately slow in the upper part, very slow in the lower part
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface
Special characteristics: The underlying dense till, which restricts root penetration

Inclusions

Contrasting inclusions:
• The very poorly drained Cathro soils, which are in landscape positions similar to those of the Prebish soil
• The somewhat poorly drained Ronneby soils, which are on low rises
• Soils that contain more clay and silt; in landscape positions similar to those of the Prebish soil

Similar soils:
• Soils that are shallower to dense glacial till
• Soils that are deeper to dense till
• Soils that have a surface layer of mucky loam, loam, or fine sandy loam
• Soils that have more cobbles in the subsoil

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• The major crops are corn and small grain.
• A drainage system is needed for optimum crop production.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• If the soil is worked when it is too wet, it becomes compacted and forms clods.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Deferring grazing during wet periods minimizes surface compaction.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w
Windbreak suitability group: Drained—2W; undrained—10

328B—Sartell fine sand, 1 to 6 percent slopes

Composition

Sartell soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 80 acres

Typical Profile

0 to 8 inches—very dark grayish brown fine sand
8 to 25 inches—dark brown fine sand
25 to 60 inches—brown fine sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low or moderately low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The somewhat poorly drained Lino soils, which are on low rises

Similar soils:
• Soils that have thin bands of finer textured material in the underlying material
• Soils that have coarser sand in the underlying material
• Soils that have a surface layer of loamy fine sand, sand, or loamy sand

Use and Management

Cropland

Major management factors: Droughtiness and wind erosion (fig. 8)
• The major crops are corn, soybeans, small grain, and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 7

328C—Sartell fine sand, 6 to 12 percent slopes

Composition

Sartell soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains

Figure 8.—An area of Sartell fine sand, 1 to 6 percent slopes. This soil erodes easily if it is not protected from the wind.

Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 5 inches—very dark grayish brown fine sand
5 to 29 inches—dark brown fine sand
29 to 60 inches—brown fine sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low or moderately low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The somewhat poorly drained Lino soils, which are on low rises

Similar soils:
• Soils that have thin bands of finer textured material in the underlying material

• Soils that have coarser sand in the underlying material
• Soils that have a surface layer of loamy fine sand, sand, or loamy sand

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of excessive droughtiness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 7

328D—Sartell fine sand, 12 to 25 percent slopes

Composition

Sartell soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Summits and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 4 inches—very dark grayish brown fine sand
4 to 26 inches—dark brown fine sand
26 to 60 inches—brown fine sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: Low or moderately low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Soils that have loamy glacial till in the underlying material
• The very poorly drained Isanti soils, which are in depressions and drainageways
• Well drained soils that have a thick, dark surface layer; on toe slopes

Similar soils:
• Soils that have thin bands of finer textured material in the underlying material
• Soils that have coarser sand in the underlying material

Use and Management

Cropland

Major management factors: Generally unsuited to crops because of severe droughtiness and the slope

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.
• The slope limits some management practices and increases the hazard of erosion.

Interpretive Groups

Land capability classification: 7s
Windbreak suitability group: 7

337—Warman loam

Composition

Warman soil and similar soils: 90 to 98 percent
Contrasting inclusions: 2 to 10 percent

Setting

Landform and position on the landform: Drainageways and depressions on outwash plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 10 inches—black loam
10 to 14 inches—dark brown, mottled loam
14 to 34 inches—brown, mottled sandy loam
34 to 60 inches—brown, mottled sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid in the upper part, rapid or very rapid in the lower part
Available water capacity: Moderate
Organic matter content: High or very high
Surface runoff: Very slow or ponded

Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Lino soils, which are on low rises
• The very poorly drained Markey soils, which are in depressions

Similar soils:
• Soils that have a surface layer of muck that is less than 16 inches thick
• Soils that have more gravel in the underlying material
• Soils that have a surface layer of fine sandy loam, silt loam, or very fine sandy loam

Use and Management

Cropland

Major management factor: Wetness
• The major crops are corn, soybeans, and small grain.
• A drainage system is needed for optimum crop production, but establishing a drainage system can be difficult in areas that do not have suitable outlets.
• Droughtiness is a hazard in drained areas because of the moderate available water capacity, especially during the latter part of the growing season.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Deferring grazing during wet periods minimizes surface compaction.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w
Windbreak suitability group: Drained—2W; undrained—10

346—Talmoon loam

Composition

Talmoon soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Drainageways and swales on ground moraines
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 9 inches—black loam
9 to 12 inches—grayish brown, mottled silt loam
12 to 24 inches—grayish brown, mottled clay loam
24 to 60 inches—grayish brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate in the upper part, moderately slow in the lower part
Available water capacity: High
Organic matter content: Moderate
Surface runoff: Slow
Depth to the water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton soils, which are in depressions
• The somewhat poorly drained and moderately well drained Beltrami soils, which are on slight rises

Similar soils:
• Soils that have a thicker surface layer
• Soils that have free carbonates at a depth of less than 60 inches
• Soils that have a surface layer of fine sandy loam, silt loam, sandy loam, or very fine sandy loam

Use and Management

Cropland

Major management factors: Wetness and compaction
• The major crops are corn, soybeans, and small grain.
• A drainage system is needed for optimum crop production.
• If worked when it is too wet, the soil becomes compacted and forms clods.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Deferring grazing during wet periods minimizes surface compaction.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: 2w
Windbreak suitability group: 2

454B—Mahtomedi loamy sand, 1 to 6 percent slopes

Composition

Mahtomedi soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes, knolls, and summits on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy sand
8 to 22 inches—dark yellowish brown loamy sand
22 to 34 inches—brown gravelly coarse sand
34 to 40 inches—dark brown coarse sand
40 to 60 inches—brown and dark brown sand and coarse sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Very low
Organic matter content: Very low or low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat excessively drained Chetek soils, which are in landscape positions similar to those of the Mahtomedi soil
• The well drained Cushing and Nebish soils, which are in landscape positions similar to those of the Mahtomedi soil
• The excessively drained Sartell, Nymore, and Zimmerman soils, which are in landscape positions similar to those of the Mahtomedi soil

Similar soils:
• Soils that have a surface layer of sandy loam, loamy coarse sand, or gravelly coarse sand
• Soils that have more than 35 percent gravel or rock fragments
• Soils that have free carbonates at a depth of less than 60 inches

Use and Management

Cropland

Major management factors: Droughtiness and wind erosion
• The major crops are corn, small grain, and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• A system of conservation tillage helps to control wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 7

454C—Mahtomedi loamy sand, 6 to 12 percent slopes

Composition

Mahtomedi soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes, knolls, and summits on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 8 inches—very dark brown loamy sand
8 to 29 inches—dark yellowish brown sand
29 to 51 inches—dark yellowish brown coarse sand
51 to 60 inches—dark brown coarse sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Very low
Organic matter content: Very low or low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat excessively drained Chetek soils,

which are in landscape positions similar to those of the Mahtomedi soil
• The well drained Cushing and Nebish soils, which are in landscape positions similar to those of the Mahtomedi soil
• The excessively drained Sartell, Nymore, and Zimmerman soils, which are in landscape positions similar to those of the Mahtomedi soil

Similar soils:
• Soils that have a surface layer of sandy loam, loamy coarse sand, or gravelly coarse sand
• Soils that have more than 35 percent gravel or rock fragments

Use and Management

Cropland

Major management factors: Droughtiness and wind erosion
• The major crops are small grain and hay.
• The low available water capacity causes moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• A system of conservation tillage helps to control wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 7

454D—Mahtomedi loamy sand, 12 to 20 percent slopes

Composition

Mahtomedi soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes and summits on outwash plains
Shape of areas: Irregular or elongated
Size of areas: 3 to 50 acres

Typical Profile

0 to 4 inches—very dark grayish brown loamy sand
4 to 12 inches—dark brown loamy coarse sand
12 to 24 inches—dark yellowish brown gravelly coarse sand
24 to 34 inches—yellowish brown coarse sand
34 to 60 inches—dark brown gravelly coarse sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Very low
Organic matter content: Very low or low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat excessively drained Chetek soils, which are in landscape positions similar to those of the Mahtomedi soil
• The well drained Cushing and Nebish soils, which are in landscape positions similar to those of the Mahtomedi soil
• The excessively drained Sartell and Nymore soils, which are in landscape positions similar to those of the Mahtomedi soil

Similar soils:
• Soils that have a surface layer of loamy coarse sand, sand, coarse sand, or gravelly coarse sand
• Soils that have more than 35 percent gravel or rock fragments

Use and Management

Cropland

Major management factors: Generally unsuited to crops because of excessive droughtiness and the slope

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 7

454F—Mahtomedi loamy sand, 20 to 35 percent slopes

Composition

Mahtomedi soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes and summits on outwash plains
Shape of areas: Irregular or somewhat elongated
Size of areas: 3 to 30 acres

Typical Profile

0 to 3 inches—black loamy sand
3 to 9 inches—dark yellowish brown loamy sand
9 to 60 inches—dark yellowish brown gravelly sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Very low
Organic matter content: Very low or low
Surface runoff: Medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat excessively drained Chetek soils, which are in landscape positions similar to those of the Mahtomedi soil
• The excessively drained Nymore soils, which are in landscape positions similar to those of the Mahtomedi soil
• The very poorly drained Warman soils, which are in depressions

Similar soils:
• Soils that have a surface layer of loamy coarse sand, sand, coarse sand, or gravelly coarse sand
• Soils that have more than 35 percent gravel or rock fragments

Use and Management

Cropland

Major management factors: Generally unsuited to crops because of excessive droughtiness and the slope

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.
• The slope limits some management practices and increases the hazard of erosion.

Interpretive Groups

Land capability classification: 7s
Windbreak suitability group: 7

540—Seelyeville muck

Composition

Seelyeville soil and similar soils: 90 to 98 percent
Contrasting inclusions: 2 to 10 percent

Setting

Landform and position on the landform: Depressions on outwash plains and ground moraines
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to more than 1,000 acres

Typical Profile

0 to 32 inches—black muck
32 to 36 inches—very dark brown mucky peat
36 to 60 inches—black muck

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton and Newson soils, which are in landscape positions similar to those of the Seelyeville soil

Similar soils:
• Soils that have loamy or sandy underlying material at a depth of less than 60 inches
• Soils that primarily consist of less well decomposed organic material

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• The major crops are specialty crops, cultured sod, and corn.
• A drainage system is needed for optimum crop production, but establishing a drainage system can be difficult in areas that do not have suitable outlets.
• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• Deferring grazing during wet periods minimizes the formation of hummocks.

• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w

Windbreak suitability group: Drained—2(O); undrained—10

543—Markey muck

Composition

Markey soil and similar soils: 90 to 98 percent
Contrasting inclusions: 2 to 10 percent

Setting

Landform and position on the landform: Depressions on outwash plains

Slope range: 0 to 1 percent

Shape of areas: Irregular

Size of areas: 3 to 300 acres

Typical Profile

0 to 30 inches—very dark brown muck
30 to 60 inches—grayish brown sand

Soil Properties and Qualities

Drainage class: Very poorly drained

Permeability: Moderately slow to moderately rapid in the upper part, rapid in the lower part

Available water capacity: Very high

Organic matter content: Very high

Surface runoff: Very slow or ponded

Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:

• The very poorly drained Isanti, Newson, and Warman soils, which are in landscape positions similar to those of the Markey soil

Similar soils:

• Soils that have muck less than 16 or more than 51 inches thick over the underlying material

• Soils that formed in less well decomposed organic material

Use and Management

Cropland

Major management factors: Wetness and wind erosion

• The major crops are specialty crops, cultured sod, and corn.

• A drainage system is needed for optimum crop production, but establishing a drainage system can be difficult in areas that do not have suitable outlets.

• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• Deferring grazing during wet periods minimizes the formation of hummocks.

• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w

Windbreak suitability group: Drained—2(O); undrained—10

544—Cathro muck

Composition

Cathro soil and similar soils: 90 to 98 percent
Contrasting inclusions: 2 to 10 percent

Setting

Landform and position on the landform: Depressions on lake plains and ground moraines

Slope range: 0 to 1 percent

Shape of areas: Irregular

Size of areas: 3 to 300 acres

Typical Profile

0 to 38 inches—black muck
38 to 60 inches—dark grayish brown loam

Soil Properties and Qualities

Drainage class: Very poorly drained

Permeability: Moderately slow to moderately rapid in the upper part, moderately slow or moderate in the lower part

Available water capacity: Very high

Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton soils, which are in landscape positions similar to those of the Cathro soil

Similar soils:
• Soils that have muck less than 16 or more than 51 inches thick over the underlying material
• Soils that formed in less well decomposed organic material

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• The major crops are specialty crops, cultured sod, and corn.
• A drainage system is needed for optimum crop production, but establishing a drainage system can be difficult in areas that do not have suitable outlets.
• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Deferring grazing during wet periods minimizes the formation of hummocks.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w
Windbreak suitability group: Drained—2(O); undrained—10

545—Rondeau muck

Composition

Rondeau soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

Setting

Landform and position on the landform: Seep areas on side slopes of ground moraines
Slope range: 0 to 1 percent
Shape of areas: Elongated or irregular
Size of areas: 3 to 300 acres

Typical Profile

0 to 8 inches—very dark grayish brown, calcareous muck
8 to 16 inches—black, calcareous muck
16 to 29 inches—very dark brown, calcareous muck
29 to 39 inches—very dark grayish brown, calcareous mucky peat
39 to 60 inches—light gray, calcareous marl

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid in the upper part, slow or very slow in the lower part
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow
Depth to the water table: 1 foot above to 1 foot below the surface
Special characteristics: Raised springs and seep areas

Inclusions

Contrasting inclusions:
• The very poorly drained Newson and Warman soils, which are in drainageways

Similar soils:
• Soils that have marl at a depth of more than 60 inches

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• Most areas are undrained and are not used for crop production.
• A drainage system is needed for optimum crop production, but establishing a drainage system can be difficult in areas that do not have suitable outlets.
• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Deferring grazing during wet periods minimizes the formation of hummocks.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w

Windbreak suitability group: Drained—2(O); undrained—10

565—Eckvoll loamy sand

Composition

Eckvoll soil and similar soils: 85 to 90 percent
Contrasting inclusions: 10 to 15 percent

Setting

Landform and position on the landform: Side slopes, summits, and low rises on ground moraines
Slope range: 0 to 3 percent
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy sand
8 to 24 inches—dark brown loamy sand
24 to 30 inches—dark yellowish brown, mottled loam
30 to 45 inches—grayish brown, mottled clay loam
45 to 60 inches—light brownish gray, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderately rapid in the upper part, moderate in the lower part
Available water capacity: Moderate
Organic matter content: Moderate or moderately low
Surface runoff: Slow
Depth to the water table: 2 to 5 feet

Inclusions

Contrasting inclusions:
• The somewhat poorly drained Alstad soils, which are on low rises
• The poorly drained Blomford soils, which are in drainageways
• The very poorly drained Kratka soils, which are in depressions

Similar soils:
• Soils that have a surface layer of loamy fine sand or fine sand
• Soils that are well drained
• Soils that have silty underlying material

Use and Management

Cropland

Major management factors: Droughtiness and wind erosion
• The major crops are corn, small grain, and hay.
• The moderate available water capacity results in moisture stress for crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 3s
Windbreak suitability group: 1

676B—Kost loamy fine sand, 1 to 6 percent slopes

Composition

Kost soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, side slopes, and summits on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 300 acres

Typical Profile

0 to 8 inches—black loamy fine sand
8 to 12 inches—very dark brown loamy fine sand
12 to 17 inches—very dark grayish brown loamy fine sand
17 to 29 inches—dark yellowish brown fine sand
29 to 60 inches—yellowish brown fine sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Moderately rapid in the upper part, rapid in the lower part
Available water capacity: Low
Organic matter content: Moderately low
Surface runoff: Slow
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Isanti soils, which are in depressions and drainageways
• The excessively drained Zimmerman soils, which are in landscape positions similar to those of the Kost soil

Similar soils:
• Soils that have a thinner or lighter colored surface layer
• Soils that have a surface layer of loamy very fine sand, very fine sand, or sand

Use and Management

Cropland

Major management factors: Droughtiness and wind erosion
• The major crops are corn, soybeans, small grain, and hay.
• The low available water capacity results in moisture stress for most crops during most years.
• Irrigation can maximize crop production.
• In nonirrigated areas, crops that can tolerate drought are the best suited.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 4s
Windbreak suitability group: 7

677—Siren silt loam

Composition

Siren soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Plane or slightly convex slopes on isolated glacial lake plains or stream terraces
Slope range: 0 to 3 percent
Shape of areas: Irregular
Size of areas: 10 to 200 acres

Typical Profile

0 to 2 inches—very dark gray silt loam
2 to 4 inches—grayish brown silt loam
4 to 6 inches—grayish brown silt loam and reddish brown silty clay loam
6 to 11 inches—reddish brown, mottled silty clay loam
11 to 34 inches—reddish brown silty clay
34 to 42 inches—yellowish red silty clay loam
42 to 60 inches—yellowish red, calcareous silty clay loam

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part, moderately slow or slow in the lower part
Available water capacity: High
Organic matter content: Moderate
Surface runoff: Slow
Depth to the water table: 1 to 3 feet
Special characteristics: Areas of springs and hillside seeps

Inclusions

Contrasting inclusions:
• The very poorly drained Prebish and Warman soils, which are in depressions
• Soils that have a surface layer of silty clay or clay
• Soils that have sandy underlying material

Similar soils:
• Soils that do not have mottles in the profile
• Soils that have less clay in the underlying material
• Soils that have a surface layer of silt loam, fine sandy loam, or loam

Use and Management

Cropland

Major management factors: Wetness and compaction
• Most areas are used as pasture or woodland and are not cultivated, but some areas are used for small grain or hay.
• A drainage system is needed for optimum crop production.
• If worked when it is too wet, the soil becomes compacted and forms clods.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Deferring grazing during wet periods minimizes surface compaction.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: 2w
Windbreak suitability group: 1

678—Beltrami loam, thick solum

Composition

Beltrami soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Level areas and low, convex rises on ground moraines
Slope range: 0 to 3 percent
Shape of areas: Irregular
Size of areas: 3 to 80 acres

Typical Profile

0 to 8 inches—very dark grayish brown loam
8 to 11 inches—light brownish gray sandy loam
11 to 19 inches—dark yellowish brown clay loam
19 to 32 inches—dark yellowish brown, mottled clay loam
32 to 60 inches—light olive brown, mottled clay loam

Soil Properties and Qualities

Drainage class: Somewhat poorly drained and moderately well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderate
Surface runoff: Slow
Depth to the water table: 2 to 4 feet

Inclusions

Contrasting inclusions:
• The very poorly drained Bluffton soils, which are in depressions
• The well drained Nebish soils, which are on summits and side slopes
• The moderately well drained Eckvoll soils, which are in landscape positions similar to those of the Beltrami soil

Similar soils:
• Soils that have a surface layer of sandy loam or fine sandy loam
• Soils that are poorly drained

Use and Management

Cropland

Major management factors: Well suited to intensive cultivation
• The major crops are corn, soybeans, small grain, and hay.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

Interpretive Groups

Land capability classification: 1
Windbreak suitability group: 1

682B—Milaca sandy loam, 2 to 6 percent slopes, very stony

Composition

Milaca soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 6 inches—very dark gray sandy loam
6 to 16 inches—dark brown sandy loam
16 to 60 inches—reddish brown sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part, very slow in the lower part
Available water capacity: Low
Organic matter content: Low
Surface runoff: Medium
Depth to the water table: More than 6 feet
Special characteristics: The underlying dense till, which

restricts root penetration and may perch water for brief periods, and surface stones, which limit cultivation

Inclusions

Contrasting inclusions:
• The very poorly drained Prebish soils, which are in depressions
• The somewhat poorly drained Ronneby soils, which are in drainageways and swales
• The well drained and moderately well drained Pomroy soils, which are in landscape positions similar to those of the Milaca soil
• Soils that have fewer stones or no stones on the surface

Similar soils:
• Soils that have more clay in the subsoil
• Soils that have a surface layer of very fine sandy loam, fine sandy loam, loam, or silt loam
• Soils that are moderately well drained

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the excessive stoniness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and stoniness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Pasture management is limited by the surface stoniness. The size and quantity of the stones make removal impractical.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 4F

682C—Milaca sandy loam, 6 to 12 percent slopes, very stony

Composition

Milaca soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 6 inches—very dark gray sandy loam
6 to 15 inches—brown sandy loam
15 to 60 inches—reddish brown sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part, very slow in the lower part
Available water capacity: Low
Organic matter content: Low
Surface runoff: Medium or rapid
Depth to the water table: More than 6 feet
Special characteristics: The underlying dense till, which restricts root penetration and may perch water for brief periods, and surface stones, which limit cultivation

Inclusions

Contrasting inclusions:
• The very poorly drained Prebish soils, which are in depressions
• The somewhat poorly drained Ronneby soils, which are in drainageways
• The well drained and moderately well drained Pomroy soils, which are in landscape positions similar to those of the Milaca soil
• Soils that have fewer stones or no stones on the surface

Similar soils:
• Soils that have a surface layer of very fine sandy loam, fine sandy loam, loam, or silt loam
• Soils that are moderately well drained

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the excessive stoniness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and stoniness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Pasture management is limited by the surface stoniness. The size and quantity of the stones make removal impractical.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 4F

682D—Milaca sandy loam, 12 to 18 percent slopes, very stony

Composition

Milaca soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 6 inches—very dark gray sandy loam
6 to 14 inches—dark brown sandy loam
14 to 60 inches—reddish brown sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part, very slow in the lower part
Available water capacity: Low
Organic matter content: Low
Surface runoff: Rapid
Depth to the water table: More than 6 feet
Special characteristics: The underlying dense till, which restricts root penetration and may perch water for brief periods, and surface stones, which limit cultivation

Inclusions

Contrasting inclusions:
• The very poorly drained Prebish soils, which are in depressions
• The somewhat poorly drained Ronneby soils, which are in drainageways
• The well drained and moderately well drained Pomroy soils, which are in landscape positions similar to those of the Milaca soil
• Soils that have fewer stones or no stones on the surface

Similar soils:
• Soils that have more sand and gravel in the underlying material
• Soils that have a surface layer of very fine sandy loam, fine sandy loam, loam, or silt loam
• Soils that are moderately well drained

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the excessive stoniness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and stoniness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Pasture management is limited by the surface stoniness. The size and quantity of the stones make removal impractical.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 4F

682E—Milaca sandy loam, 18 to 25 percent slopes, very stony

Composition

Milaca soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes and shoulder slopes on ground moraines
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 4 inches—very dark grayish brown sandy loam
4 to 16 inches—dark brown sandy loam
16 to 22 inches—reddish brown sandy loam
22 to 60 inches—dark reddish brown sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part, very slow in the lower part
Available water capacity: Low
Organic matter content: Low
Surface runoff: Rapid
Depth to the water table: More than 6 feet
Special characteristics: The underlying dense till, which restricts root penetration and may perch water for brief periods, and surface stones, which limit cultivation

Inclusions

Contrasting inclusions:
• The very poorly drained Prebish soils, which are in depressions
• The somewhat poorly drained Ronneby soils, which are in drainageways

• The excessively drained Mahtomedi soils, which are in landscape positions similar to those of the Milaca soil
• Soils that have fewer stones or no stones on the surface

Similar soils:
• Soils that have a surface layer of very fine sandy loam, fine sandy loam, loam, or silt loam
• Soils that are moderately well drained

Use and Management

Cropland

Major management factors: Generally unsuited to crops because of the excessive stoniness and the slope

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and stoniness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Pasture management is limited by the surface stoniness. The size and quantity of the stones make removal impractical.
• The slope limits some management practices and increases the hazard of erosion.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 4F

717B—Novak silt loam, 0 to 6 percent slopes

Composition

Novak soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 8 inches—very dark grayish brown silt loam
8 to 17 inches—dark brown silt loam
17 to 34 inches—dark brown silt loam
34 to 38 inches—dark brown sandy loam
38 to 60 inches—brown, calcareous sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate in the upper part, rapid or very rapid in the lower part
Available water capacity: Moderate
Organic matter content: Moderate
Surface runoff: Slow or medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The somewhat excessively drained Chetek soils, which are in landscape positions similar to those of the Novak soil
• Moderately well drained soils in concave swales and drainageways

Similar soils:
• Soils that have a thinner or thicker silty mantle
• Soils that have more gravel in the underlying material

Use and Management

Cropland

Major management factors: Wind erosion and water erosion
• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of water erosion.
• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Droughtiness is a hazard because of the moderate available water capacity, especially during the latter part of the growing season.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, and fertility
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: 2e
Windbreak suitability group: 6G

722—Blomford loamy sand, lacustrine substratum

Composition

Blomford soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Drainageways and swales on ground moraines
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 8 inches—very dark gray loamy sand
8 to 24 inches—grayish brown, mottled loamy sand
24 to 37 inches—grayish brown, mottled silty clay loam
37 to 60 inches—grayish brown, mottled silt loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Rapid in the upper part, moderate in the lower part
Available water capacity: Moderate
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: 0.5 foot to 1.5 feet

Inclusions

Contrasting inclusions:
• The moderately well drained Eckvoll soils, which are on side slopes and low rises
• The very poorly drained Kratka soils, which are in depressions

Similar soils:
• Soils that have a thinner or thicker sandy mantle
• Soils that have a surface layer of sand, fine sand, or loamy fine sand
• Soils that have loam, fine sandy loam, or clay loam in the underlying material

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• The major crops are corn, soybeans, and hay.
• A drainage system is needed for optimum crop production.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Leaving crop residue on the surface reduces the hazard of wind erosion.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: 3w
Windbreak suitability group: Drained—2; undrained—10

726—Kratka loamy fine sand, thick solum

Composition

Kratka soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Depressions and drainageways on ground moraines
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 10 inches—very dark grayish brown loamy fine sand
10 to 30 inches—grayish brown, mottled fine sand
30 to 60 inches—grayish brown, mottled clay loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Rapid in the upper part, moderately slow or moderate in the lower part
Available water capacity: Moderate
Organic matter content: Moderately low or moderate
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• The very poorly drained Markey soils, which are in depressions

Similar soils:
• Soils that have a sandy mantle that is more than 40 inches thick or less than 20 inches thick
• Soils that have a gravelly layer as much as 6 inches thick at the base of the sandy mantle
• Soils that have a surface layer of loamy sand, sandy loam, or fine sandy loam
• Soils that are poorly drained

Use and Management

Cropland

Major management factors: Wetness and wind erosion
• The major crops are corn and small grain.
• A drainage system is needed for optimum crop production, but establishing a drainage system can be difficult in areas that do not have adequate outlets.

• Leaving crop residue on the surface reduces the hazard of wind erosion.
• Droughtiness is a hazard because of the moderate available water capacity.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and wetness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: Drained—4w; undrained—6w
Windbreak suitability group: Drained—2W; undrained—10

792—Fordum sandy loam, frequently flooded

Composition

Fordum soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Drainageways and broad, level areas on flood plains
Slope range: 0 to 2 percent
Shape of areas: Elongated
Size of areas: 10 to 300 acres

Typical Profile

0 to 26 inches—very dark gray sandy loam
26 to 40 inches—dark gray, mottled sandy loam
40 to 60 inches—dark grayish brown, mottled loamy sand

Soil Properties and Qualities

Drainage class: Poorly drained or very poorly drained
Permeability: Moderate or moderately rapid in the upper part, rapid in the lower part
Available water capacity: Moderate
Organic matter content: Moderate to very high
Surface runoff: Very slow or ponded
Depth to the water table: 1 foot above to 1 foot below the surface
Flooding: Frequent for brief or long periods

Inclusions

Contrasting inclusions:
• The moderately well drained Caryville soils, which are on low, convex rises
• Very poorly drained organic soils in depressions and oxbows

Similar soils:
• Soils that have as much as 16 inches of muck on the surface
• Soils that have a surface layer of fine sandy loam, silt loam, loam, or very fine sandy loam

Use and Management

Cropland

Major management factors: Generally unsuited to crops because of the flooding and the wetness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and flooding
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Flooding limits the choice of plants and periods of grazing.
• Deferring grazing during wet periods minimizes surface compaction.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: 6w
Windbreak suitability group: 10

928B—Mahtomedi-Cushing complex, 2 to 6 percent slopes

Composition

Mahtomedi soil and similar soils: 45 to 65 percent
Cushing soil and similar soils: 20 to 40 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

Mahtomedi

0 to 8 inches—very dark grayish brown loamy sand
8 to 22 inches—dark yellowish brown loamy sand
22 to 34 inches—brown gravelly coarse sand
34 to 40 inches—dark brown coarse sand
40 to 45 inches—brown sand and coarse sand
45 to 60 inches—dark brown coarse sand

Cushing

0 to 5 inches—black loam
5 to 12 inches—brown loam
12 to 40 inches—dark brown clay loam
40 to 60 inches—dark brown loam

Soil Properties and Qualities

Drainage class: Mahtomedi—excessively drained; Cushing—well drained
Permeability: Mahtomedi—rapid; Cushing—moderate in the upper part, moderately slow in the lower part
Available water capacity: Mahtomedi—very low; Cushing—high
Organic matter content: Mahtomedi—very low or low; Cushing—moderately low or moderate
Surface runoff: Mahtomedi—slow; Cushing—medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The well drained Braham soils, which are in landscape positions similar to those of the Mahtomedi and Cushing soils
• The poorly drained Talmoon soils, which are in swales and drainageways

Similar soils:
• Soils that have a surface layer of fine sand or loamy fine sand
• Soils that are calcareous throughout
• Soils that contain more clay in the subsoil and underlying material
• Soils that contain more than 35 percent gravel
• Soils that have a gravelly surface layer

Use and Management

Cropland

Major management factors: Wind erosion, water erosion, and droughtiness
• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of erosion.
• Drought is a hazard in some areas in most years.
• Crop growth can be quite variable over short distances.
• An irrigation system can help to overcome the drought hazard. Because of the contrasting soil patterns, however, irrigation may be difficult to manage.
• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: Mahtomedi—4s; Cushing—2e
Windbreak suitability group: Mahtomedi—7; Cushing—3

928C—Mahtomedi-Cushing complex, 6 to 12 percent slopes

Composition

Mahtomedi soil and similar soils: 45 to 65 percent
Cushing soil and similar soils: 20 to 40 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

Mahtomedi

0 to 8 inches—very dark brown loamy sand
8 to 29 inches—dark yellowish brown sand
29 to 51 inches—dark yellowish brown coarse sand
51 to 60 inches—dark brown coarse sand

Cushing

0 to 8 inches—very dark grayish brown loam
8 to 14 inches—brown sandy loam and dark brown loam
14 to 33 inches—dark yellowish brown clay loam
33 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Drainage class: Mahtomedi—excessively drained; Cushing—well drained
Permeability: Mahtomedi—rapid; Cushing—moderate in the upper part, moderately slow in the lower part
Available water capacity: Mahtomedi—very low; Cushing—high
Organic matter content: Mahtomedi—very low or low; Cushing—moderately low or moderate

Surface runoff: Mahtomedi—slow; Cushing—medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The well drained Braham soils, which are in landscape positions similar to those of the Mahtomedi and Cushing soils
• The poorly drained Talmoon soils, which are in swales and drainageways

Similar soils:
• Soils that have a surface layer of fine sand or loamy fine sand
• Soils that are calcareous throughout
• Soils that have more clay in the subsoil and underlying material
• Soils that have more than 35 percent gravel
• Soils that have a gravelly surface layer

Use and Management

Cropland

Major management factors: Wind erosion, water erosion, and droughtiness
• The major crops are corn, soybeans, small grain, and hay.
• Using conservation practices, such as conservation tillage and crop rotation, and establishing grassed waterways in areas where runoff concentrates reduce the hazard of erosion.
• Drought is a hazard in some areas during most years.
• Crop growth can vary over short distances.
• An irrigation system can help to overcome the drought hazard. Because of the contrasting soil patterns, however, irrigation may be difficult to manage.
• Returning crop residue to the soil and adding other organic material improve tilth.
• Contour farming and contour stripcropping are suitable practices in some areas.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness
• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: Mahtomedi—4s; Cushing—3e
Windbreak suitability group: Mahtomedi—7; Cushing—3

928D—Mahtomedi-Cushing complex, 12 to 20 percent slopes

Composition

Mahtomedi soil and similar soils: 45 to 65 percent
Cushing soil and similar soils: 20 to 40 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls, summits, and side slopes
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

Mahtomedi

0 to 4 inches—very dark grayish brown loamy sand
4 to 12 inches—dark yellowish brown loamy coarse sand
12 to 24 inches—dark yellowish brown coarse sand
24 to 34 inches—yellowish brown coarse sand
34 to 60 inches—yellowish brown gravelly coarse sand

Cushing

0 to 7 inches—dark brown loam
7 to 26 inches—dark yellowish brown clay loam
26 to 40 inches—dark brown loam
40 to 60 inches—dark yellowish brown loam

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Mahtomedi—rapid; Cushing—moderate in the upper part, moderately slow in the lower part
Available water capacity: Mahtomedi—very low; Cushing—high
Organic matter content: Mahtomedi—very low or low; Cushing—moderately low or moderate
Surface runoff: Mahtomedi—slow; Cushing—medium
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• The excessively drained Zimmerman and Sartell soils, which are in landscape positions similar to those of the Mahtomedi and Cushing soils
• The well drained Braham soils, which are in landscape positions similar to those of the Mahtomedi and Cushing soils

Similar soils:
• Soils that are calcareous throughout
• Soils that have more clay in the subsoil and underlying material
• Soils that have more than 35 percent gravel
• Soils that have a gravelly surface layer

Use and Management

Cropland

Major management factors: Generally unsuited to crops because of the slope and droughtiness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

Interpretive Groups

Land capability classification: Mahtomedi—6s; Cushing—4e

Windbreak suitability group: Mahtomedi—7; Cushing—3

1030—Udorthents-Pits, gravel, complex

This map unit occurs as areas of active or abandoned sand and gravel pits. It consists of excavations, stock piles of sand and gravel, and areas filled with waste material. Individual areas range from about 3 to 100 acres in size and are irregular in shape. Included in mapping are borrow pits from which loamy material has been removed.

Areas of this unit can be reclaimed and used for a variety of purposes. Some areas are beginning to revegetate naturally with grasses and brush. Reclamation generally includes extensive filling and grading. Some areas can be reclaimed for agricultural uses if the topsoil is stockpiled. Some reclaimed areas can be used for commercial or industrial development. Areas that include ponds can be used for wildlife habitat or recreational uses if vegetation is established.

Onsite investigation is needed to determine the potentials and limitations of these areas for any proposed use.

This map unit is not assigned to interpretive groups.

1068—Caryville sandy loam, occasionally flooded

Composition

Caryville soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises and drainageways on flood plains

Slope range: 0 to 3 percent
Shape of areas: Elongated
Size of areas: 3 to 300 acres

Typical Profile

0 to 10 inches—very dark grayish brown sandy loam
10 to 60 inches—stratified dark yellowish brown sand and very dark grayish brown very fine sandy loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderately rapid or rapid
Available water capacity: Low
Organic matter content: Moderate or moderately low
Surface runoff: Slow
Depth to the water table: 4 to 6 feet
Flooding: Occasional, for brief periods

Inclusions

Contrasting inclusions:

• The poorly drained and very poorly drained Fordum soils, which are in the lower parts of drainageways

Similar soils:

• Soils that are rarely flooded and are well drained

• Soils that have a surface layer of loamy sand or loamy fine sand

Use and Management

Cropland

Major management factors: Occasional flooding, droughtiness, and wind erosion

• The major crops are small grain and hay.

• Flooding may prevent timely field operations or may reduce crop yields in some years.

• The low available water capacity results in moisture stress for most crops during most years.

• Irrigation can maximize crop yields.

• In nonirrigated areas, crops that tolerate drought are the best suited.

• Leaving crop residue on the surface reduces the hazard of wind erosion.

• Returning crop residue to the soil and adding other organic material improve tilth.

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and droughtiness

• The quantity and quality of forage can be improved by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• Introducing adapted warm-season grasses helps to provide additional forage during hot and dry periods.

• The occasional flooding can limit grazing.

Interpretive Groups

Land capability classification: 3w
Windbreak suitability group: 1

1069C—Fairport-Rock outcrop complex, 2 to 12 percent slopes

Composition

Fairport soil and similar soils: 50 to 70 percent
Rock outcrop: 15 to 30 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Fairport—summits and side slopes on till plains; Rock outcrop—side slopes
Shape of areas: Irregular or somewhat elongated
Size of areas: 3 to 100 acres

Typical Profile

Fairport

0 to 5 inches—very dark grayish brown silt loam
5 to 8 inches—dark brown silt loam
8 to 24 inches—brown loam
24 inches—basalt

Properties and Qualities of the Fairport Soil

Drainage class: Well drained
Permeability: Moderate
Available water capacity: Low
Organic matter content: Moderately low or moderate
Surface runoff: Medium or rapid
Depth to bedrock: 20 to 40 inches
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Well drained soils that are more than 40 inches deep over bedrock; on side slopes
• Areas of rock outcrop that have steeper slopes

Similar soils:
• Soils that contain more sand
• Soils that have a surface layer of loam, sandy loam, fine sandy loam, or very fine sandy loam
• Soils that are underlain by sandstone or limestone

Use and Management

Cropland

Major management factors: Generally not used for crops because of the Rock outcrop and droughtiness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and the Rock outcrop

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• The Rock outcrop limits pasture management.

Interpretive Groups

Land capability classification: Fairport—7s; Rock outcrop—8s
Windbreak suitability group: Fairport—6R; Rock outcrop—10

1070D—Plainbo-Rock outcrop complex, 12 to 40 percent slopes

Composition

Plainbo soil and similar soils: 50 to 70 percent
Rock outcrop: 15 to 30 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Plainbo—summits and side slopes on stream terraces; Rock outcrop—side slopes
Shape of areas: Irregular or somewhat elongated
Size of areas: 3 to 300 acres

Typical Profile

Plainbo

0 to 5 inches—very dark grayish brown loamy sand
5 to 23 inches—dark yellowish brown loamy sand
23 inches—basalt

Properties and Qualities of the Plainbo Soil

Drainage class: Excessively drained
Permeability: Rapid
Available water capacity: Very low
Organic matter content: Low or very low
Surface runoff: Medium to very rapid
Depth to bedrock: 20 to 40 inches
Depth to the water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Excessively drained soils that are more than 40 inches over bedrock; on side slopes
• Areas of rock outcrop that have steeper slopes

Similar soils:
• Soils that have more clay
• Soils that have a surface layer of sand or loamy fine sand
• Soils that are underlain by sandstone or limestone

Use and Management

Cropland

Major management factors: Generally not used for crops because of the Rock outcrop and the slope

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and the Rock outcrop

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• The Rock outcrop, escarpments, and the slope make pasture management impractical.

Interpretive Groups

Land capability classification: Plainbo—7s; Rock outcrop—8s

Windbreak suitability group: Plainbo—7; Rock outcrop—10

1977—Mora loam, very stony

Composition

Mora soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Side slopes and low rises on ground moraines
Slope range: 1 to 3 percent
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 4 inches—very dark gray loam
4 to 12 inches—dark brown loam
12 to 30 inches—dark brown, mottled sandy loam
30 to 50 inches—reddish brown, mottled sandy loam
50 to 60 inches—reddish brown, mottled sandy loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderate or moderately rapid in the upper part, very slow in the lower part
Available water capacity: Moderate
Organic matter content: Low to moderate
Surface runoff: Slow
Depth to the water table: 2 to 3 feet
Special characteristics: The underlying dense till, which restricts root penetration, and surface stones, which limit cultivation

Inclusions

Contrasting inclusions:

• The well drained Pomroy soils, which are on knolls and side slopes

• The very poorly drained Prebish soils, which are in depressions

• Soils that have fewer stones on the surface

Similar soils:

• Soils that are well drained or somewhat poorly drained

• Soils that have a surface layer of fine sandy loam, sandy loam, or very fine sandy loam

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the excessive surface stoniness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, and stoniness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.

• Pasture management is limited by the surface stoniness. The size and quantity of the stones make removal impractical.

Interpretive Groups

Land capability classification: 6s
Windbreak suitability group: 4F

1980—Ronneby loam, extremely stony

Composition

Ronneby soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Drainageways and level areas on ground moraines (fig. 9)
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 7 inches—very dark gray loam
7 to 19 inches—dark grayish brown, mottled sandy loam
19 to 35 inches—reddish gray, mottled sandy loam
35 to 44 inches—reddish brown, mottled sandy loam
44 to 60 inches—reddish brown sandy loam

Figure 9.—An area of Ronneby loam, extremely stony. This soil is suited to pasture and to wildlife habitat.

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Moderately rapid or moderate in the upper part, very slow in the lower part
Available water capacity: Moderate
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to the water table: 1.5 to 3.0 feet
Special characteristics: The underlying dense till, which restricts root penetration, and surface stones, which limit cultivation

Inclusions

Contrasting inclusions:
• The well drained Milaca soils, which are on summits and side slopes
• The very poorly drained Prebish soils, which are in depressions
• Soils that have fewer stones on the surface or that do not have stones

Similar soils:
• Soils that are moderately well drained

• Soils that have a surface layer of fine sandy loam, silt loam, sandy loam, or very fine sandy loam

Use and Management

Cropland

Major management factor: Generally unsuited to crops because of the excessive surface stoniness

Pasture and forage

Major management factors: Overgrazing, weed control, fertility, stoniness, and wetness

• The quality and quantity of forage can be maintained by using a planned grazing system; by controlling weeds, brush, and excessive growth; and by properly applying fertilizer.
• Pasture management is limited by the surface stoniness. The size and quantity of the stones make removal impractical.
• Deferring grazing during wet periods minimizes surface compaction.
• Grass species that are adapted to wetness should be selected.

Interpretive Groups

Land capability classification: 7s
Windbreak suitability group: 4F

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 82,000 acres in the survey area, or about 31 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in associations 1, 2, 3, and 4, which are described under the heading "General Soil Map Units." About 60,000 acres of this prime farmland is used for crops. The crops grown on this land are mainly corn, soybeans, and small grain.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Jeffrey J. Schmidt, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1982, approximately 108,500 acres in Chisago County was used as cropland and 51,100 acres was used for pasture. In 1988, the acreage of cropland had decreased to about 99,800 acres. Of this, 60,700 acres was used for row crops, such as corn and soybeans, and 11,900 acres was used for small grain, primarily oats and rye. Nearly 30,000 acres was used for hay or forage, mostly alfalfa, clovers, and smooth bromegrass. Timothy and orchardgrass were also used in mixtures.

Urban development resulting from expansion of the Minneapolis-St. Paul metropolitan area has been a factor in the decrease in the acreage of cropland in recent years. The continued expansion of urban areas and increasing concerns about water quality may result in the conversion of more cropland to areas in which a permanent cover of grass, legumes, shrubs, and trees is maintained.

In 1988, about 7,800 acres in the county was used for horticulture. This acreage included nurseries, small landscaping plantations, orchards, and areas used for vegetable crops, such as radishes, rutabagas, turnips, beets, carrots, and potatoes.

The acreage of pastureland has increased slightly each year since about 1985, partly because a number of larger farms have been split into smaller tracts. In 1988, about 54,300 acres was used for pasture.

Most of the cropland in Chisago County is susceptible to erosion. The hazard of erosion ranges from slight to severe. As the surface layer is removed by erosion, nutrients and organic matter are lost. The sediment that is produced settles at the base of slopes or in nearby depressions or enters rivers and lakes and

affects water quality. The soils in the county that are the most susceptible to water erosion are those that have slopes of more than 6 percent. Nebish loam, 6 to 12 percent slopes, and Cushing loam, 12 to 20 percent slopes, are examples. The hazard of water erosion can be reduced by returning crop residue to the soil and by using conservation tillage practices, such as chisel plowing, mulch tillage, strip tillage, ridge tillage, or no-till. Conservation tillage helps to control sheet erosion and rill erosion, and grassed waterways or water- and sediment-control basins help to control gully erosion.

The kind of conservation tillage used depends on several factors, including soil texture, drainage, slope, and the crops being grown. Using tillage methods that leave a small amount of crop residue on the surface and using ridge tillage for row crops are practical on somewhat poorly drained soils and on wetter soils in the less sloping areas. Methods that leave a large amount of crop residue on the surface, including strip tillage and no-till, are preferable on soils that are well drained, such as Anoka and Cushing soils.

Conservation tillage can also reduce fuel consumption and equipment costs, conserve moisture, improve wildlife habitat, and improve water quality. The Soil Conservation Service and the Cooperative Extension Service can provide assistance in selecting crop residue management practices and conservation tillage systems for specific situations.

Other methods of controlling water erosion on cropland include crop rotation, contour farming, terraces and diversions, and stripcropping. In many areas, however, the slopes are too short and uneven for contour farming, stripcropping, or terraces.

Many of the soils in the survey area are susceptible to wind erosion. These soils typically have a surface layer of loamy fine sand, loamy very fine sand, loamy sand, fine sandy loam, or fine sand. Examples are Sartell fine sand, 1 to 6 percent slopes, and Lino loamy fine sand. Organic soils, such as Seelyeville and Markey soils, are also susceptible to wind erosion in areas where drainage is adequate and the fields are left without a plant cover on the surface during late winter and early spring. Creating a rough surface, decreasing the size of fields, and leaving crop residue on the surface help to control wind erosion.

Surface roughness can be created by some tillage methods. On mineral soils that have been moldboard plowed in the fall, leaving the surface rough and cloddy can reduce the hazard of wind erosion. Using a chisel plow instead of a moldboard plow creates a more stable, well defined pattern of ridges and valleys and leaves a cover of crop residue on the surface. If the ridges are arranged so that they are perpendicular to the direction of the wind, the hazard of wind erosion can be reduced by as much as 50 percent.

Establishing stable vegetative borders, establishing field windbreaks, and stripcropping reduce the size of fields. Information about species selection, the proper location of vegetative barriers and field windbreaks, and wind stripcropping practices can be obtained from the Soil Conservation Service and the Soil and Water Conservation District.

Erosion is especially damaging on soils that have a sandy surface layer and a low or moderate available water capacity, such as Lino and Braham soils. These soils may also be subject to late-season droughtiness. Conservation practices that help to control erosion can also increase the rate of water infiltration and the amount of moisture available to crops by reducing the runoff rate and trapping snow cover.

Soil wetness is a limitation in many low-lying and depressional areas. The soils in these areas include the poorly drained Talmoon and Kratka soils and the very poorly drained Isanti and Markey soils. Wetness on these soils can severely hinder crop production unless a drainage system is installed. Installing a drainage system on some soils, such as Talmoon and Isanti soils, can be difficult because adequate outlets are not available. Depressional areas are commonly 1 to 3 acres in size. Maintaining these small wetland areas is beneficial to nesting waterfowl.

Open field ditches are commonly used to drain excess water. The spacing of these ditches depends on the type of soil and the depth at which the ditches can be installed. Large areas of the organic Seelyeville and Markey soils are commonly drained if adequate outlets are available. The "Minnesota Drainage Guide" provides guidelines for draining wet soils *(8)*.

Soil tilth is an important management concern in the areas used for crops. Soils that have good tilth are granular and porous. Soils that have poor tilth have large clods, which interfere with seedbed preparation, the germination and emergence of seeds, the intake of nutrients by plants, and the water-holding capacity of the soil. If moderately fine textured soils are cultivated when they are wet, tilth is damaged and the surface and subsurface layers can become compacted. Tilth can be maintained or improved by returning crop residue to the soil, applying manure or other organic waste, growing green manure crops, and limiting tillage operations. A crop rotation that includes grass-legume mixtures helps to loosen the soil and improves tilth. Maintaining good tilth increases the rate of water infiltration, promotes efficient use of plant nutrients, and helps the soil to warm up faster in the spring.

Irrigation can increase yields in areas of droughty

soils, such as Sartell, Mahtomedi, and Pomroy soils. Because these soils have a low water-holding capacity, regular additions of water are needed. A wide variety of crops can be grown in irrigated areas. Irrigation is especially beneficial for turf grass and specialty crops, such as radishes, carrots, beets, and potatoes.

On most of the soils in the county, crops respond well to applications of fertilizer. The need for fertilizer varies, depending on the type of soil, past and present management practices, erosion hazard, and the needs of the crop. The kinds and amounts of fertilizer to apply should be based on the results of soil tests. Droughtiness, excessive wetness, or an imbalance of nutrients can reduce the effectiveness of fertilizers. Applications of lime are commonly needed in the county to increase the pH to an adequate level for crop production. A proper pH level is particularly important if alfalfa is included in the crop rotation.

Most of the pasture in Chisago County is in areas where the soils are not suited to crops because of the slope, wetness, or droughtiness. Pastures can be improved by applying fertilizer, controlling weeds and brush, rotating pastures or deferring grazing, and adjusting stocking rates during wet periods. Overgrazing can cause compaction on stock trails, which results in erosion or in the formation of gullies on the steeper slopes. Controlled grazing helps to maintain vigorous plant growth and an adequate vegetative cover.

Summer forage can be increased by incorporating a warm-season grass in the rotation. Big bluestem, switchgrass, and indiangrass are well suited to pasture production during the summer. In many areas, pastures can be improved by reseeding to more productive species. Species selection should be based on the type of soil, drainage conditions, and the planned time of use.

Well drained to somewhat poorly drained soils, such as Cushing and Alstad soils, are well suited to a wide range of plant species, including alfalfa, birdsfoot trefoil, smooth bromegrass, timothy, orchardgrass, sweetclover, red clover, and reed canarygrass.

Very poorly drained soils, such as Bluffton, Isanti, and Prebish soils, are suited only to species that are adapted to wet conditions. Adapted species include reed canarygrass, creeping foxtail, alsike clover, birdsfoot trefoil, and redtop. If a drainage system is installed, timothy, smooth bromegrass, Kentucky bluegrass, and red clover are also suitable.

Excessively drained soils, such as Zimmerman, Nymore, Mahtomedi, and Sartell soils, generally produce forage in spring, early summer, and fall, when precipitation is adequate. Droughty conditions limit production during most of the summer. Alfalfa, red clover, birdsfoot trefoil, smooth bromegrass, orchardgrass, timothy, and Kentucky bluegrass are suitable species in areas of these soils if an adequate supply of moisture is available.

Warm-season grasses, such as big bluestem, little bluestem, switchgrass, and indiangrass, are adapted to many soil drainage conditions. These species can provide good forage during the summer months if proper management practices are applied. Using warm-season grasses in combination with cool-season pasture species provides a complete forage program. Current information regarding species adaptation and variety selection of grasses and legumes is available at local offices of the Soil Conservation Service and the Cooperative Extension Service.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class 1 soils have few limitations that restrict their use.

Class 2 soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class 3 soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class 4 soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class 5 soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class 6 soils have severe limitations that make them generally unsuitable for cultivation.

Class 7 soils have very severe limitations that make them unsuitable for cultivation.

Class 8 soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class number, for example, 2e. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class 1 there are no subclasses because the soils of this class have few limitations. Class 5 contains only the subclasses indicated by *w, s,* or *c* because the soils in class 5 are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

By Thomas A. Fait, area soil scientist, Soil Conservation Service.

Prior to its settlement, almost all of Chisago County was wooded. Forest types and the density of trees and understory were variable. Although fire and other disturbances affected the composition and extent of the forests, there was a general pattern of forest types. The nutrient-rich, loamy till soils in the northwestern and southeastern parts of the county supported stands of bur oak, white oak, and red oak. Sugar maple, red maple, basswood, hickory, aspen, birch, butternut, ironwood, hornbeam, and white pine also grew in these areas, which were referred to as the "Big Woods." In the central part of the county, the nutrient-poor Anoka Sand Plain consisted of oak openings and barrens. Bur oak grew as single trees and in groves. Grass and brush were common. Conifer bogs, grasslands, river-bottom forests, and areas of aspen, oak, and pine were scattered throughout the county. Most areas had been logged by the early 1900's.

About 85 percent of the woodland in Chisago County is privately owned. Most of this land is in small tracts. The hardwood stands are generally not actively managed, but some of the stands are harvested for firewood, sawlogs, and wood for veneer. The upland conifers, which consist of red pine and Scotch pine, are grown on plantations and are used primarily for Christmas trees or round-wood production. Nearly all of the plantations, which make up about 1,200 acres, are on the Anoka Sand Plain.

About 15 percent of the woodland is owned by the State. Minor holdings are owned by Federal and county governments. State-owned forest land is mostly in parks along the St. Croix River and within the Carlos Avery Wildlife Management Area. Forest management in the parks is limited to selective cutting and pruning to control diseases, such as oak wilt and white-pine blister rust.

A unique feature of the St. Croix River Valley is the diversity of vegetation. This diversity results from the

convergence of two general life zones—the Carolinian, from the south, and the boreal, from the north. Nearly all of the tree species that once grew throughout the survey area still grow in the river valley.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

At the end of each description under the heading "Detailed Soil Map Units," each soil has been assigned to a windbreak suitability group. These groups are based primarily on the suitability of the soil for the locally adapted species, as indicated by their growth and vigor. Detailed interpretations for each windbreak suitability group in the county are provided in the "Technical Guide," which is available in the local office of the Soil Conservation Service.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

The soils in Chisago County are assigned to 11 different windbreak suitability groups. These groups are described in the paragraphs that follow. Site preparation on soils that are subject to severe water erosion should be limited to spot treatment extending 2 feet from where a plant is established.

Windbreak suitability group 1.—This group consists dominantly of somewhat poorly drained and moderately well drained soils that have a moderately high water table. Permeability is moderate, moderately rapid, or moderately slow. The soils generally do not have free carbonates in the upper 20 inches. A few of the soils may be subject to flooding, but the flooding is not severe enough to adversely affect tree growth.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 2.—This group consists dominantly of poorly drained soils that have a high water table. These soils have been artificially drained. They do not have free carbonates in the upper 20 inches. A few of the soils may be subject to flooding, but the flooding is not severe enough to adversely affect tree growth.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of wetness. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 2(O).—This group consists dominantly of very poorly drained, depressional soils that have organic material more than 16 inches thick. These soils have been artificially drained.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of extreme wetness. Because of the wetness, seedling mortality is severe and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 2W.—This group consists dominantly of very poorly drained, depressional soils that are subject to ponding. These soils have been artificially drained.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of extreme wetness. Because of the wetness, seedling mortality is severe and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 3.—This group consists dominantly of well drained and moderately well drained, loamy and silty soils. Permeability is moderate, moderately rapid, or moderately slow. The soils generally do not have free carbonates in the upper 20 inches.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 4F.—This group consists dominantly of well drained, moderately well drained, or somewhat poorly drained soils that have a dense subsurface layer. Permeability is slow or very slow.

A wide variety of trees and shrubs can be grown as

windbreaks and environmental plantings on these soils. The hazard of water erosion is severe in areas that have slopes of more than 18 percent. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 5.—This group consists dominantly of well drained soils that have a moderate or high available water capacity.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 6G.—This group consists of excessively drained to well drained soils that have sand at a depth of 20 to 40 inches. These soils have a low available water capacity.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of droughty conditions. Leaving a plant cover on the surface during the early years of establishment helps to control wind erosion.

Windbreak suitability group 6R.—This group consists of well drained soils that have bedrock at a depth of 20 to 40 inches. These soils have a low or moderate available water capacity.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 7.—This group consists dominantly of well drained to excessively drained soils that have a low available water capacity.

The trees and shrubs grown as windbreaks and environmental plantings on these soils should be those that are tolerant of droughty conditions. The seedling mortality rate is moderate because of the moisture stress caused by droughtiness. Leaving a plant cover on the surface during the early years of establishment helps to control wind erosion. Cultivation or applications of herbicide help to remove competing vegetation.

Windbreak suitability group 10.—This group consists dominantly of soils or miscellaneous areas that generally are not suitable for windbreaks. Ponding or rock outcrops prevent the growth of trees and shrubs. Onsite investigation may identify areas where trees and shrubs can be planted. Special management is needed in these areas.

Recreation

The many lakes, streams, and wooded hills in Chisago County provide good opportunities for recreational development. Ideal picnic areas, campsites, and scenic overlooks are along the St. Croix River. The lakes in the county are used for boating, swimming, and fishing. County and city parks provide picnic areas, hiking trails, athletic fields, swimming beaches, and other recreational facilities.

Interstate Park and the Wild River State Park offer a wide range of recreational facilities, including areas for camping, picnicking, cross-country skiing, canoeing, and horseback riding. Bicycle and snowmobile trails are well established in the county. Some of the rolling hills along the St. Croix River Valley are well suited to the development of ski runs and toboggan runs. A downhill skiing facility is north of Taylors Falls.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but

remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Phil Hartzberg, district technician, Chisago County Soil and Water Conservation District, helped prepare this section.

Chisago County has a variety of wildlife habitat areas. Deer, bear, pheasant, coyote, ducks, geese, grouse, woodcock, turkeys, squirrels, rabbits, and Hungarian partridge are the major wildlife species. The deer inhabit areas throughout the county, but they are concentrated along the major rivers and streams, where there is adequate cover. Habitat management efforts for pheasant are concentrated in four major areas where adequate winter and nesting cover is available. These areas are east of Goose Lake, in the northern part of the county; near Almelund; between Sunrise Pools and Green Lake, in the southern part of the county; and in the area east of the Chisago Chain of Lakes. They are mainly in areas of the Cushing-Talmoon and Nebish-Talmoon soils.

Because of the decrease in wetland habitat areas, the duck populations are smaller than they once were. In recent years, however, the number of Canada geese in the area has increased significantly.

Furbearing animals, such as mink, muskrat, and beaver, are common around the major rivers and streams and in wetland basins. Fox, coyote, and black bear are in the northern part of the county and along the St. Croix River. The smaller mammals, such as squirrels and rabbits, are throughout the county.

Bald eagles inhabit the St. Croix River Valley and nest around some of the isolated lakes. An island in Rush Lake is managed as a heron rookery.

Two major areas in the county are managed for the protection of wildlife. The Sunrise Pools area is managed primarily for waterfowl. It is part of the Carlos Avery Refuge and Management Area. In recent years, efforts to establish wild turkey in this area have been successful. The St. Croix River Valley is managed by both State and Federal agencies, primarily for recreational uses.

Chisago County has 91 lakes, 26 of which are classified as fish lakes and 65 of which are classified as game lakes. These lakes contain northern pike, walleye, bass, sunfish, and crappies. The St. Croix River has catfish, smallmouth bass, walleye, and sturgeon. Sturgeon have also been caught in the lakes that have outlets flowing into the St. Croix River. Brook trout are in several of the spring-fed tributaries.

Urban development has had an effect on wildlife habitat, especially in the southern part of the county. An increase in homesite development has reduced the acreage of wildlife habitat in this area and, in some cases, eliminated the habitat entirely. Urban development has also resulted in the pollution of lakes and streams. Development along the shorelines of some lakes has resulted in artificial fluctuation of water levels, which can influence the quality and quantity of fish.

Wildlife habitat can be improved by applying a variety of conservation measures. Establishing farmstead shelterbelts and field windbreaks, using conservation tillage and crop rotation, seeding ditch banks and field borders, and establishing filter strips around water areas can help to protect the wildlife habitat and fisheries in the county.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated

according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, milkweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, dogwood, raspberry, and blackberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, Siberian peashrub, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the

most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or to very firm, dense glacial till; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrinking and swelling, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface

and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin

layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of the soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as

shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table and permeability of the aquifer. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The

design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone and by soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind erosion or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

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Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

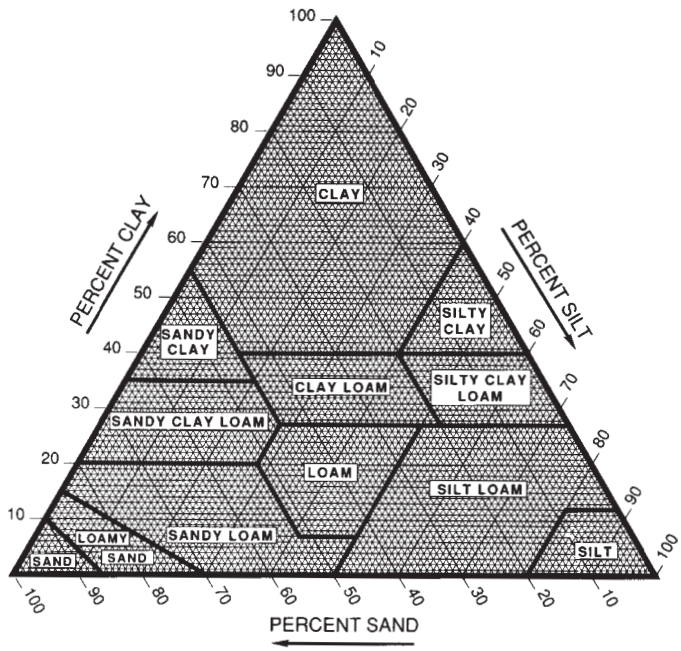

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under the heading "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering

properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓-bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained

sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 16 shows the expected total subsidence, which usually is a result of oxidation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are

the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

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Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(6)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boralf (*Bor*, meaning cold, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Eutroboralfs (*Eutro*, meaning high base saturation, plus *boralf*, the suborder of the Alfisols that has a cold temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Eutroboralfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, mixed Typic Eutroboralfs.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(7)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(6)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Alstad Series

Depth class: Very deep
Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part; moderately slow in the lower part
Landform: Ground moraines

Parent material: Glacial till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed Glossaquic Eutroboralfs

Typical Pedon

Alstad loam, 2,300 feet north and 300 feet east of the southwest corner of sec. 4, T. 37 N., R. 21 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; many fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

E—9 to 13 inches; brown (10YR 5/3) loam; few fine faint light brownish gray (10YR 6/2) mottles; weak thin platy structure; friable; few fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

B/E—13 to 25 inches; 70 percent yellowish brown (10YR 5/4) loam (Bt), 30 percent brown (10YR 5/3) loam (E); common medium distinct grayish brown (10YR 5/2) mottles; weak medium platy structure parting to weak very fine subangular blocky; friable; few fine roots; common faint dark yellowish brown (10YR 4/4) clay films on faces of peds; about 2 percent gravel; strongly acid; gradual wavy boundary.

Bt—25 to 39 inches; dark yellowish brown (10YR 4/4) clay loam; common medium distinct grayish brown (10YR 5/2) mottles; strong fine and medium angular blocky structure; firm; few fine roots; common faint dark brown (10YR 4/3) clay films on faces of peds; about 2 percent gravel; strongly acid; gradual wavy boundary.

C—39 to 60 inches; dark yellowish brown (10YR 4/4) loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; friable; few fine roots; about 2 percent gravel; neutral.

Range in Characteristics

Depth to carbonates: 40 to more than 60 inches
Content of rock fragments: 1 to 10 percent throughout the profile

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—loam

E horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 or 5
Chroma—2 or 3
Texture—loam, silt loam, or sandy loam

B/E horizon:
Colors and textures similar to those of the E and Bt horizons

Bt horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 or 5
Chroma—3 or 4
Texture—clay loam, loam, sandy clay loam, or sandy loam

C horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 or 5
Chroma—2 to 4
Texture—loam, sandy loam, sandy clay loam, or clay loam

Anoka Series

Depth class: Very deep
Drainage class: Well drained
Permeability: Moderate
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 1 to 12 percent
Taxonomic class: Coarse-loamy, mixed Eutric Glossoboralfs

The Anoka soils in Chisago County are taxadjuncts to the series because the base saturation in the argillic horizon is more than 60 percent. This difference, however, does not alter the use and management of the soils.

Typical Pedon

Anoka loamy very fine sand, 1 to 6 percent slopes, 100 feet south and 1,575 feet east of the northwest corner of sec. 32, T. 33 N., R. 21 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy very fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; common fine roots; moderately acid; abrupt smooth boundary.

E—9 to 25 inches; dark brown (10YR 4/3) loamy fine sand; massive; very friable; few fine roots; slightly acid; clear wavy boundary.

Bt—25 to 36 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak fine angular blocky structure; firm; few fine roots; few faint dark brown (10YR 4/3) clay films on faces of peds; slightly acid; clear wavy boundary.

E and Bt—36 to 51 inches; brown (10YR 5/3) fine sand (E); single grain; loose; lamellae and bands of

dark yellowish brown (10YR 4/4) loamy very fine sand (Bt); weak fine subangular blocky structure; firm; dark brown (10YR 4/3) clay bridges between sand grains; few fine roots; moderately acid; gradual wavy boundary.

C—51 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; few fine roots; slightly acid.

Range in Characteristics

Depth to carbonates: More than 60 inches

A horizon:
Hue—10YR
Value—3 or 4
Chroma—1 or 2
Texture—loamy very fine sand

E horizon:
Hue—10YR
Value—4 to 6
Chroma—2 to 4
Texture—loamy fine sand, loamy very fine sand, very fine sand, or fine sand

E and Bt horizon:
Colors and textures similar to those of the E horizon and the Bt horizon

Bt horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—3 to 5
Texture—fine sandy loam, loamy very fine sand, or very fine sandy loam

C horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—3 or 4
Texture—fine sand or very fine sand

Beltrami Series

Depth class: Very deep
Drainage class: Somewhat poorly drained and moderately well drained
Permeability: Moderate
Landform: Ground moraines
Parent material: Glacial till
Slope range: 0 to 3 percent
Taxonomic class: Fine-loamy, mixed Aquic Eutroboralfs

Typical Pedon

Beltrami loam, thick solum, 200 feet south and 2,300 feet west of the northeast corner of sec. 1, T. 33 N., R. 20 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine and very fine subangular blocky structure; friable; few fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

E—8 to 11 inches; light brownish gray (10YR 6/2) sandy loam; weak thin platy structure; friable; few fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Bt1—11 to 19 inches; dark yellowish brown (10YR 4/4) clay loam; weak medium subangular blocky structure parting to very fine subangular blocky; firm; few fine roots; common faint dark brown (10YR 3/3) clay films on faces of peds; about 5 percent gravel; strongly acid; gradual wavy boundary.

Bt2—19 to 32 inches; dark yellowish brown (10YR 4/4) clay loam; few fine and medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; few fine roots; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; about 5 percent gravel; strongly acid; gradual wavy boundary.

BC—32 to 60 inches; light olive brown (2.5YR 5/4) clay loam; common medium prominent grayish brown (10YR 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; few fine roots; about 5 percent gravel; neutral.

Range in Characteristics

Depth to carbonates: More than 60 inches
Content of rock fragments: 2 to 10 percent throughout the profile

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—loam

E horizon:
Hue—10YR or 2.5YR
Value—4 to 6
Chroma—1 or 2
Texture—sandy loam, loam, or fine sandy loam

Bt horizon:
Hue—10YR or 2.5YR
Value—4 or 5
Chroma—3 or 4
Texture—clay loam, loam, or sandy clay loam

BC horizon:
Hue—10YR or 2.5YR
Value—5 or 6

Chroma—2 to 4
Texture—clay loam, loam, or sandy clay loam

Blomford Series

Depth class: Very deep
Drainage class: Poorly drained
Permeability: Rapid in the upper part; moderate in the lower part
Landform: Ground moraines
Parent material: Glacial outwash and the underlying lacustrine material
Slope range: 0 to 2 percent
Taxonomic class: Loamy, mixed, frigid Arenic Ochraqualfs

Typical Pedon

Blomford loamy sand, lacustrine substratum, 2,100 feet north and 1,900 feet east of the southwest corner of sec. 16, T. 36 N., R. 21 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loamy sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; few fine roots; neutral; abrupt smooth boundary.

Eg1—8 to 16 inches; grayish brown (10YR 5/2) loamy sand; common fine faint brown (10YR 5/3) mottles; weak medium subangular blocky structure; very friable; few fine roots; strongly acid; clear wavy boundary.

Eg2—16 to 24 inches; grayish brown (10YR 5/2) loamy sand; common medium distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; very friable; few fine roots; strongly acid; clear wavy boundary.

2Btg—24 to 37 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium prominent strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; friable; few fine roots; few prominent dark yellowish brown (10YR 4/4) clay films on faces of peds; strongly acid; gradual wavy boundary.

2Cg—37 to 60 inches; grayish brown (2.5Y 5/2) silt loam; many medium prominent yellowish brown (10YR 5/4) mottles; massive; friable; few fine roots; slightly acid.

Range in Characteristics

Depth to carbonates: 36 to more than 60 inches
Thickness of the sandy mantle: 20 to 40 inches
Content of rock fragments: 0 to 1 percent throughout the profile

Ap horizon:
Hue—10YR
Value—2 to 4
Chroma—1 or 2
Texture—loamy sand

Eg horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—1 to 3
Texture—loamy sand, sand, fine sand, or loamy fine sand

2Btg horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 to 6
Chroma—1 or 2
Texture—silty clay loam or silt loam

2Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 to 3
Texture—silt loam or silty clay loam

Bluffton Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid in the upper part; moderately slow in the lower part
Landform: Ground moraines
Parent material: Local alluvium overlying glacial till
Slope range: 0 to 1 percent
Taxonomic class: Fine-loamy, mixed, frigid Typic Haplaquolls

Typical Pedon

Bluffton loam, 2,500 feet south and 400 feet east of the northwest corner of sec. 28, T. 33 N., R. 20 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common roots; about 1 percent gravel; slightly acid; abrupt smooth boundary.

A—9 to 19 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common roots; about 1 percent gravel; slightly acid; gradual wavy boundary.

Bg—19 to 40 inches; olive gray (5Y 5/2) loam; few fine prominent light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; few fine roots; about 2 percent gravel; neutral; gradual wavy boundary.

Cg—40 to 60 inches; olive gray (5Y 5/2) loam; few fine prominent light olive brown (2.5Y 5/4) mottles; massive; friable; few fine roots; about 2 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 48 inches
Thickness of the mollic epipedon: 7 to 24 inches
Content of rock fragments: 1 to 10 percent throughout the profile

A horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Texture—loam

Bg horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 or 2
Texture—loam, clay loam, or sandy clay loam

Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—loam, sandy clay loam, or fine sandy loam

Braham Series

Depth class: Very deep
Drainage class: Well drained
Permeability: Rapid in the upper part; moderate in the lower part
Landform: Ground moraines
Parent material: Glacial outwash and the underlying glacial till
Slope range: 2 to 12 percent
Taxonomic class: Loamy, mixed Arenic Eutroboralfs

Typical Pedon

Braham loamy fine sand, 2 to 6 percent slopes, 520 feet south and 500 feet east of the northwest corner of sec. 5, T. 34 N., R. 20 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; few fine roots; moderately acid; clear smooth boundary.

E—8 to 20 inches; brown (10YR 5/3) loamy fine sand; weak medium subangular blocky structure; very friable; few fine roots; slightly acid; clear wavy boundary.

2Bt—20 to 41 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium angular blocky structure; friable; few fine roots; common faint dark brown (10YR 4/3) clay films on faces of peds; about 2 percent gravel; neutral; gradual wavy boundary.

2C—41 to 60 inches; dark yellowish brown (10YR 4/4) loam; massive; friable; few fine roots; about 2 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 38 to 60 inches
Thickness of the sandy mantle: 20 to 40 inches
Content of rock fragments: 1 to 10 percent in the underlying material

Ap horizon:
Hue—10YR
Value—2 to 4
Chroma—1 to 3
Texture—loamy fine sand

E horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—2 or 3
Texture—loamy fine sand, fine sand, loamy sand, or sand

2Bt horizon:
Hue—10YR
Value—4 or 5
Chroma—3 or 4
Texture—clay loam, loam, fine sandy loam, or sandy clay loam

2C horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—loam, sandy clay loam, or clay loam

Caryville Series

Depth class: Very deep
Drainage class: Moderately well drained
Permeability: Moderately rapid
Landform: Flood plains
Parent material: Stratified sandy and loamy alluvium
Slope range: 0 to 3 percent
Taxonomic class: Sandy, mixed Fluventic Haploborolls

Typical Pedon

Caryville sandy loam, occasionally flooded, 700 feet south and 600 feet east of the northwest corner of sec. 27, T. 33 N., R. 19 W.

A—0 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; few fine roots; moderately acid; clear smooth boundary.

2C—10 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; few fine roots; few strata

of very dark grayish brown (10YR 3/2) very fine sandy loam; neutral.

Range in Characteristics

Content of rock fragments: 0 to 5 percent throughout the profile

A horizon:
Hue—10YR or 7.5YR
Value—2 or 3
Chroma—2 or 3
Texture—sandy loam

2C horizon:
Hue—10YR or 7.5YR
Value—4 to 6
Chroma—3 to 6
Texture—loamy fine sand, fine sand, sand, or loamy sand that has strata of very fine sandy loam or sandy loam

Cathro Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid in the upper part; moderately slow or moderate in the lower part
Landform: Lake plains and ground moraines
Parent material: Highly decomposed herbaceous plant material overlying loamy glacial till
Slope range: 0 to 1 percent
Taxonomic class: Loamy, mixed, euic Terric Borosaprists

Typical Pedon

Cathro muck, 700 feet south and 2,590 feet east of the northwest corner of sec. 8, T. 34 N., R. 19 W.

Oa1—0 to 4 inches; muck, black (10YR 2/1) rubbed and pressed; about 35 percent fiber, about 5 percent rubbed; weak fine subangular blocky structure; primarily herbaceous fibers; moderately acid; clear wavy boundary.

Oa2—4 to 38 inches; muck, black (10YR 2/1) broken face and rubbed; about 25 percent fiber, about 3 percent rubbed; weak medium subangular blocky structure; primarily herbaceous fibers; moderately acid; clear wavy boundary.

Cg—38 to 60 inches; dark grayish brown (2.5Y 4/2) loam; massive; friable; few fine roots; about 2 percent gravel; neutral.

Range in Characteristics

Thickness of the organic material: 16 to 51 inches

Content of rock fragments: 0 to 15 percent in the underlying material

Oa horizon:
Hue—10YR, 7.5YR, or neutral
Value—2 or 3
Chroma—0 to 3
Texture—muck

Cg horizon:
Hue—2.5Y, 5Y, 10YR, or 7.5YR
Value—4 to 6
Chroma—1 to 3
Texture—loam, silt loam, sandy loam, or clay loam

Chetek Series

Depth class: Shallow or moderately deep over coarse textured material
Drainage class: Somewhat excessively drained
Permeability: Moderately rapid in the upper part; rapid and very rapid in the lower part
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 1 to 12 percent
Taxonomic class: Coarse-loamy, mixed Eutric Glossoboralfs

Typical Pedon

Chetek sandy loam, 1 to 6 percent slopes, 200 feet north and 400 feet east of the southwest corner of sec. 22, T. 35 N., R. 19 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; common fine roots; about 3 percent gravel; strongly acid; clear smooth boundary.

Bt1—9 to 24 inches; dark reddish brown (5YR 3/4) sandy loam; weak medium subangular blocky structure; friable; few fine roots; common faint dark reddish brown (5YR 3/3) clay films on faces of peds; about 5 percent gravel; slightly acid; clear wavy boundary.

2Bt2—24 to 29 inches; dark brown (7.5YR 4/4) gravelly loamy sand; weak fine subangular blocky structure; very friable; few fine roots; common clay bridges between sand grains; 25 percent gravel; slightly acid; clear wavy boundary.

2C—29 to 60 inches; brown (7.5YR 5/4) gravelly sand; single grain; loose; few fine roots; about 15 percent gravel; slightly acid.

Range in Characteristics

Thickness of the loamy mantle: 10 to 24 inches

Content of rock fragments: 0 to 10 percent in the loamy mantle and 15 to 35 percent in the 2B and 2C material
Other characteristics: An E horizon in some pedons
A horizon:
Hue—10YR or 7.5YR
Value—2 to 4
Chroma—1 to 3
Texture—sandy loam
Bt horizon:
Hue—10YR, 7.5YR, or 5YR
Value—3 to 5
Chroma—3 or 4
Texture—sandy loam or loam
2Bt horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 to 6
Chroma—4 to 6
Texture—gravelly loamy sand or gravelly sandy loam
2C horizon:
Hue—7.5YR or 10YR
Value—4 or 5
Chroma—4 to 6
Texture—gravelly sand or gravelly coarse sand

Cushing Series

Depth class: Very deep
Drainage class: Well drained
Permeability: Moderate in the upper part; moderately slow in the lower part
Landform: Ground moraines
Parent material: Glacial till
Slope range: 2 to 35 percent
Taxonomic class: Fine-loamy, mixed Glossic Eutroboralfs

Typical Pedon

Cushing loam, 2 to 6 percent slopes, 2,500 feet north and 700 feet west of the southeast corner of sec. 19, T. 36 N., R. 22 W.

A—0 to 5 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; common roots; about 2 percent gravel; strongly acid; clear smooth boundary.
E—5 to 12 inches; brown (10YR 5/3) loam; weak thin platy structure; friable; few fine roots; about 1 percent gravel; strongly acid; clear wavy boundary.
B/E—12 to 24 inches; 60 percent dark brown (7.5YR 4/4) clay loam (Bt), 40 percent brown (10YR 5/3) loam (E); weak medium subangular blocky structure; friable; few fine roots; few distinct brown (10YR 4/3) clay films on faces of peds; about 2 percent gravel; strongly acid; gradual wavy boundary.
Bt—24 to 40 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few fine roots; few distinct brown (10YR 4/3) clay films on faces of peds; about 2 percent gravel; strongly acid; gradual wavy boundary.
C—40 to 60 inches; dark brown (7.5YR 4/4) loam; massive; friable; few fine roots; about 2 percent gravel; slightly acid.

Range in Characteristics

Content of rock fragments: 1 to 10 percent throughout the profile
A horizon:
Hue—10YR
Value—2 to 4
Chroma—1 to 3
Texture—loam
E horizon:
Hue—10YR
Value—4 to 6
Chroma—2 or 3
Texture—loam, sandy loam, fine sandy loam, very fine sandy loam, loamy sand, or silt loam
B/E horizon:
Colors and textures similar to those of the Bt and E horizons
Bt horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 or 5
Chroma—3 to 5
Texture—clay loam, loam, sandy clay loam, sandy loam, or fine sandy loam
C horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—3 or 4
Texture—loam, sandy loam, fine sandy loam, or sandy clay loam

Eckvoll Series

Depth class: Very deep
Drainage class: Moderately well drained
Permeability: Moderately rapid in the upper part; moderate in the lower part
Landform: Ground moraines
Parent material: Sandy sediments and the underlying glacial till
Slope range: 0 to 3 percent

Taxonomic class: Loamy, mixed Aquic Arenic Eutroboralfs

Typical Pedon

Eckvoll loamy sand, 800 feet south and 2,275 feet west of the northeast corner of sec. 31, T. 36 N., R. 21 W.

A—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to weak medium and fine granular; very friable; few fine roots; slightly acid; clear smooth boundary.

E—8 to 24 inches; dark brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; very friable; few fine roots; slightly acid; gradual wavy boundary.

2Bt1—24 to 30 inches; dark yellowish brown (10YR 4/4) loam; common medium distinct dark grayish brown (10YR 4/2) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; friable; few fine roots; few distinct dark grayish brown (10YR 4/2) clay films on faces of peds; about 4 percent gravel; slightly acid; gradual wavy boundary.

2Bt2—30 to 45 inches; grayish brown (2.5Y 5/2) clay loam; common medium prominent dark yellowish brown (10YR 4/4) and few fine prominent yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to weak fine subangular blocky; friable; common faint dark grayish brown (2.5Y 4/2) clay films on faces of peds; about 5 percent gravel; neutral; gradual wavy boundary.

2C—45 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium prominent dark yellowish brown (10YR 4/6) mottles; massive; friable; few fine roots; few fine light gray (10YR 7/2) threads of calcium carbonate; about 5 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Thickness of the sandy mantle: 20 to 36 inches
Depth to carbonates: 24 to 48 inches
Content of rock fragments: 0 to 10 percent in the sandy mantle; 2 to 10 percent in the underlying material

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—loamy sand

E horizon:
Hue—10YR
Value—4 or 5
Chroma—2 to 4
Texture—loamy sand, fine sand, or sand

2Bt horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—clay loam, loam, or sandy clay loam

2C horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—loam, clay loam, or sandy loam

Fairport Series

Depth class: Moderately deep
Drainage class: Well drained
Permeability: Moderate
Landform: Bedrock-controlled ground moraines
Parent material: Glacial till over basalt bedrock
Slope range: 2 to 12 percent
Taxonomic class: Fine-loamy, mixed Typic Eutroboralfs

Typical Pedon

Fairport silt loam, in an area of Fairport-Rock outcrop complex, 2 to 12 percent slopes; 1,000 feet north and 350 feet west of the southeast corner of sec. 11, T. 34 N., R. 19 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; common fine roots; about 2 percent gravel; neutral; clear wavy boundary.

E—5 to 8 inches; dark brown (10YR 4/3) silt loam; weak thin platy structure; friable; common fine roots; about 2 percent gravel; neutral; clear wavy boundary.

Bt—8 to 24 inches; brown (7.5YR 4/4) loam; weak medium subangular blocky structure; friable; common roots; few faint dark brown (7.5YR 4/3) clay films on faces of peds; about 2 percent gravel; neutral; abrupt wavy boundary.

2R—24 inches; very dark gray (N 3/0) basalt.

Range in Characteristics

Depth to bedrock: 20 to 40 inches
Content of rock fragments: 1 to 15 percent throughout the mantle

A horizon:
Hue—7.5YR or 10YR
Value—2 or 3
Chroma—1 to 3
Texture—silt loam

E horizon:
Hue—7.5YR or 10YR
Value—4 to 6

Chroma—2 or 3
Texture—silt loam, loam, or fine sandy loam

Bt horizon:
Hue—7.5YR
Value—4 or 5
Chroma—3 or 4
Texture—loam, clay loam, or sandy clay loam

Fordum Series

Depth class: Moderately deep over coarse textured material
Drainage class: Poorly drained and very poorly drained
Permeability: Moderate or moderately rapid in the upper part; rapid in the lower part
Landform: Flood plains
Parent material: Alluvial sediment
Slope range: 0 to 2 percent
Taxonomic class: Coarse-loamy, mixed, nonacid, frigid Mollic Fluvaquents

The Fordum soils in Chisago County are taxadjuncts because they have a mollic epipedon that is thicker than is defined as the range for the series. This difference, however, does not alter the use and management of the soils.

Typical Pedon

Fordum sandy loam, frequently flooded, 300 feet south and 350 feet east of the northwest corner of sec. 28, T. 36 N., R. 21 W.

A1—0 to 9 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; few fine roots; slightly alkaline; gradual wavy boundary.

A2—9 to 26 inches; very dark gray (10YR 3/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; few fine roots; slightly alkaline; gradual wavy boundary.

Cg1—26 to 40 inches; dark gray (10YR 4/1) sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; very friable; few thin strata of black (10YR 2/1) very fine sand; few fine roots; slightly alkaline; gradual wavy boundary.

2Cg2—40 to 60 inches; dark grayish brown (10YR 4/2) loamy sand; few fine distinct yellowish brown (10YR 5/4) mottles; massive; very friable; many thin strata of black (10YR 2/1) sandy loam; few fine roots; slight effervescence; moderately alkaline.

Range in Characteristics

Depth to sand or sand and gravel: 24 to 40 inches
Content of rock fragments: 0 to 15 percent throughout the profile

A horizon:
Hue—7.5YR, 10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 to 3
Texture—sandy loam

Cg horizon:
Hue—7.5YR, 10YR, 2.5Y, 5Y, or neutral
Value—3 to 5
Chroma—0 to 3
Texture—stratified sandy loam, loam, silt loam, very fine sandy loam, fine sand, or very fine sand

2Cg horizon:
Hue—10YR or 7.5YR
Value—4 to 6
Chroma—1 to 4
Texture—sand, fine sand, loamy sand, or loamy fine sand and thin strata of finer textured material

Halder Series

Depth class: Moderately deep over coarse textured material
Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part; rapid or very rapid in the lower part
Landform: Outwash plains
Parent material: Loamy mantle over glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed Aquic Glossoboralfs

Typical Pedon

Halder sandy loam, 1,200 feet south and 1,050 feet west of the northeast corner of sec. 13, T. 35 N., R. 21 W.

Ap—0 to 8 inches; dark brown (10YR 4/3) sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; very friable; common fine roots; about 5 percent gravel; slightly acid; abrupt smooth boundary.

E—8 to 12 inches; brown (7.5YR 5/2) sandy loam; common medium distinct dark brown (7.5YR 4/4) mottles; weak medium platy structure; very friable; common fine roots; about 5 percent gravel; slightly acid; clear wavy boundary.

B/E—12 to 18 inches; 60 percent reddish brown (5YR 4/4) sandy loam (Bt), 40 percent brown (7.5YR 5/2) sandy loam (E); common medium prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; friable; common fine

roots; about 5 percent gravel; slightly acid; clear wavy boundary.

Bt—18 to 32 inches; reddish brown (5YR 4/4) loam; common medium prominent brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; friable; common fine roots; common distinct dark brown (7.5YR 4/4) clay films on faces of peds; about 5 percent gravel; slightly acid; clear wavy boundary.

2BC—32 to 40 inches; reddish brown (5YR 4/4) loamy sand; common medium distinct reddish gray (5YR 5/2) mottles; moderate medium subangular blocky structure; very friable; few fine roots; about 5 percent gravel; slightly acid; clear wavy boundary.

2C—40 to 60 inches; reddish brown (5YR 4/4), stratified sand, loamy sand, and coarse sand; common fine distinct reddish gray (5YR 5/2) mottles; single grain; loose; few fine roots; about 5 percent gravel; slightly acid.

Range in Characteristics

Thickness of the loamy mantle: 20 to 36 inches

Content of rock fragments: 0 to 10 percent in the loamy mantle; 5 to 35 percent in the 2C horizon

A horizon:
Hue—10YR
Value—2 to 4
Chroma—2 or 3
Texture—sandy loam

E horizon:
Hue—10YR or 7.5YR
Value—4 to 6
Chroma—2 or 3
Texture—sandy loam, fine sandy loam, very fine sandy loam, loam, or silt loam

B/E horizon:
Colors and textures similar to those of the Bt and E horizons

Bt horizon:
Hue—7.5YR, 5YR, or 10YR
Value—3 to 6
Chroma—3 to 6
Texture—loam, silt loam, or sandy clay loam

2BC horizon:
Hue—5YR, 7.5YR, or 10YR
Value—3 to 6
Chroma—2 to 6
Texture—loamy sand, sandy loam, loamy coarse sand, or the gravelly analogs of those textures

2C horizon:
Hue—10YR, 7.5YR, or 5YR
Value—3 to 7
Chroma—2 to 6
Texture—sand, coarse sand, gravelly sand, gravelly loamy sand, or gravelly coarse sand

Isanti Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Sandy, mixed, frigid Typic Haplaquolls

Typical Pedon

Isanti loamy fine sand, 1,200 feet south and 2,100 feet east of the northwest corner of sec. 14, T. 34 N., R. 21 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; common fine roots; strongly acid; abrupt smooth boundary.

A—8 to 12 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; very friable; common fine roots; strongly acid; clear wavy boundary.

Bg—12 to 36 inches; grayish brown (2.5Y 5/2) fine sand; few fine prominent yellowish brown (10YR 5/4) mottles; single grain; loose; few fine roots; slightly acid; gradual wavy boundary.

Cg—36 to 60 inches; grayish brown (2.5Y 5/2) fine sand; common medium prominent yellowish brown (10YR 5/4) mottles; single grain; loose; few fine roots; slightly acid.

Range in Characteristics

Thickness of the mollic epipedon: 10 to 18 inches

A horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2
Chroma—0 or 1
Texture—loamy fine sand

Bg horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—4 or 5
Chroma—0 to 2
Texture—fine sand, sand, loamy fine sand, or loamy sand

Cg horizon:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—1 or 2

Texture—fine sand, sand, loamy sand, or loamy fine sand

Kost Series

Depth class: Very deep
Drainage class: Excessively drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 1 to 6 percent
Taxonomic class: Sandy, mixed Udorthentic Haploborolls

Typical Pedon

Kost loamy fine sand, 1 to 6 percent slopes, 2,400 feet north and 2,250 feet east of the southwest corner of sec. 25, T. 35 N., R. 21 W.

Ap—0 to 8 inches; black (10YR 2/1) loamy fine sand, dark grayish brown (10YR 4/2) dry; massive; loose; few fine roots; neutral; abrupt smooth boundary.

A—8 to 12 inches; very dark brown (10YR 2/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; massive; loose; few fine roots; neutral; clear smooth boundary.

AB—12 to 17 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; massive; loose; few fine roots; neutral; clear smooth boundary.

Bw—17 to 29 inches; dark yellowish brown (10YR 4/4) fine sand; massive; loose; few fine roots; slightly acid; gradual smooth boundary.

C—29 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; few fine roots; slightly acid.

Range in Characteristics

Thickness of the mollic epipedon: 10 to 20 inches
Content of rock fragments: 0 to 5 percent throughout the profile

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy fine sand

AB horizon:
Colors and textures similar to those of the A and Bw horizons

Bw horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—2 to 4
Texture—fine sand or sand

C horizon:
Hue—10YR or 7.5YR
Value—4 to 6
Chroma—3 to 5
Texture—fine sand or sand

Kratka Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Rapid in the upper part; moderate or moderately slow in the lower part
Landform: Ground moraines
Parent material: Sandy sediments and the underlying glacial till
Slope range: 0 to 1 percent
Taxonomic class: Sandy over loamy, mixed, frigid Typic Haplaquolls

Typical Pedon

Kratka loamy fine sand, thick solum, 165 feet north and 2,000 feet east of the southwest corner of sec. 34, T. 37 N., R. 21 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; common fine roots; moderately acid; abrupt smooth boundary.

Bg1—10 to 30 inches; grayish brown (10YR 5/2) fine sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; few fine roots; moderately acid; clear wavy boundary.

2Bg2—30 to 39 inches; grayish brown (2.5Y 5/2) clay loam; many fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine roots; about 3 percent gravel; moderately acid; clear wavy boundary.

2Cg—39 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; few fine roots; about 3 percent gravel; slightly acid.

Range in Characteristics

Thickness of the mollic epipedon: 8 to 18 inches
Thickness of the sandy mantle: 20 to 40 inches
Content of rock fragments: 1 to 10 percent in the sandy mantle; 2 to 8 percent in the underlying material

A horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Texture—loamy fine sand

Bg horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—1 or 2
Texture—fine sand, loamy fine sand, loamy sand, or sand

2Bg horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 to 3
Texture—loam or clay loam

2Cg horizon:
Hue—10YR, 2.5Y, or 5Y
Value—5 or 6
Chroma—1 to 3
Texture—clay loam, loam, silt loam, silty clay loam, or sandy loam

Lino Series

Depth class: Very deep
Drainage class: Somewhat poorly drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Mixed, frigid Aquic Udipsamments

Typical Pedon

Lino loamy fine sand, 330 feet north and 1,800 feet east of the southwest corner of sec. 31, T. 34 N., R. 21 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; common fine roots; strongly acid; abrupt smooth boundary.

Bw1—8 to 24 inches; brown (10YR 5/3) loamy fine sand; common medium prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; few fine roots; strongly acid; gradual wavy boundary.

Bw2—24 to 42 inches; yellowish brown (10YR 5/4) fine sand; many large distinct grayish brown (10YR 5/2) mottles; single grain; loose; few fine roots; moderately acid; gradual wavy boundary.

C—42 to 60 inches; brown (10YR 5/3) fine sand; common fine faint grayish brown (10YR 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; few fine roots; slightly acid.

Range in Characteristics

A horizon:
Hue—10YR
Value—2 to 4
Chroma—1 or 2
Texture—loamy fine sand

Bw horizon:
Hue—10YR
Value—4 to 6
Chroma—2 to 6
Texture—loamy fine sand, fine sand, sand, or loamy sand

C horizon:
Hue—10YR
Value—5 or 6
Chroma—2 to 4
Texture—fine sand or sand

Mahtomedi Series

Depth class: Very deep
Drainage class: Excessively drained
Permeability: Rapid
Landform: Outwash plains and ground moraines
Parent material: Glacial outwash
Slope range: 1 to 35 percent
Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Mahtomedi loamy sand, 12 to 20 percent slopes, 2,000 feet north and 400 feet east of the southwest corner of sec. 29, T. 36 N., R. 22 W.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) loamy sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; very friable; few fine roots; about 3 percent gravel; strongly acid; clear smooth boundary.

E—4 to 12 inches; dark brown (10YR 4/3) loamy coarse sand; weak fine subangular blocky structure; very friable; few fine roots; about 5 percent gravel; strongly acid; gradual wavy boundary.

Bw1—12 to 24 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; few fine roots; about 20 percent gravel; strongly acid; clear wavy boundary.

Bw2—24 to 34 inches; yellowish brown (10YR 5/6) coarse sand; single grain; loose; about 10 percent gravel; moderately acid; clear wavy boundary.

C—34 to 60 inches; dark brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 25 percent gravel; strongly acid.

Range in Characteristics

Content of rock fragments: 2 to 35 percent throughout the profile

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

E horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—1 to 3
Texture—loamy coarse sand, coarse sand, sand, loamy sand, loamy fine sand, or the gravelly analogs of those textures

Bw horizon:
Hue—10YR, 7.5YR, or 5YR
Value—3 to 5
Chroma—4 to 6
Texture—sand, coarse sand, or the gravelly analogs of those textures

C horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 to 6
Chroma—3 or 4
Texture—sand, coarse sand, or the gravelly analogs of those textures

Markey Series

Depth class: Moderately deep or deep over coarse textured material
Drainage class: Very poorly drained
Permeability: Moderately slow or moderately rapid in the upper part; rapid in the lower part
Landform: Lake plains and outwash plains
Parent material: Highly decomposed, herbaceous organic material overlying sandy glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Sandy or sandy-skeletal, mixed, euic Terric Borosaprists

Typical Pedon

Markey muck, 900 feet north and 1,900 feet west of the southeast corner of sec. 15, T. 34 N., R. 21 W.

Oa1—0 to 12 inches; muck, very dark brown (10YR 2/2) rubbed and pressed; about 20 percent fiber, about 4 percent rubbed; weak fine subangular blocky structure; primarily herbaceous fibers; neutral; gradual wavy boundary.

Oa2—12 to 30 inches; muck, very dark brown (10YR 2/2) broken face and rubbed; about 15 percent fiber, about 3 percent rubbed; weak fine subangular blocky structure; primarily herbaceous fibers; neutral; clear wavy boundary.

Cg—30 to 60 inches; grayish brown (2.5Y 5/2) sand; single grain; loose; neutral.

Range in Characteristics

Thickness of the organic material: 16 to 51 inches
Content of rock fragments: 0 to 15 percent in the underlying material

Oa horizon:
Hue—10YR, 7.5YR, or neutral
Value—2 to 4
Chroma—0 to 3
Texture—muck

Cg horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—4 to 6
Chroma—0 to 4
Texture—sand, fine sand, or loamy sand

Milaca Series

Depth class: Moderately deep over dense glacial till
Drainage class: Well drained
Permeability: Moderately rapid or moderate in the upper part; very slow in the lower part
Landform: Ground moraines
Parent material: Glacial till
Slope range: 2 to 25 percent
Taxonomic class: Coarse-loamy, mixed Typic Eutroboralfs

The Milaca soils in Chisago County are taxadjuncts because the surface layer is darker than is defined as the range for the series. This difference, however, does not alter the use and management of the soils.

Typical Pedon

Milaca sandy loam, 2 to 6 percent slopes, very stony, 150 feet north and 150 feet west of the southeast corner of sec. 6, T. 37 N., R. 20 W.

A—0 to 6 inches; very dark gray (10YR 3/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; very friable; common fine roots; about 10 percent gravel; moderately acid; clear smooth boundary.

E—6 to 16 inches; dark brown (7.5YR 4/4) sandy loam; weak thin platy structure; friable; few fine roots; about 10 percent gravel; moderately acid; clear wavy boundary.

Bt—16 to 24 inches; reddish brown (5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few fine roots; few faint dark reddish brown (5YR 3/3) clay films on faces of peds; about 10 percent gravel; slightly acid; clear wavy boundary.

BC—24 to 35 inches; reddish brown (5YR 5/4) sandy loam; massive; firm; about 12 percent gravel; slightly acid; gradual wavy boundary.

Cd—35 to 60 inches; reddish brown (5YR 5/4) sandy loam; massive; very firm; about 10 percent gravel; slightly acid.

Range in Characteristics

Depth to dense till: 20 to 40 inches

Content of rock fragments: 1 to 15 percent throughout the profile

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—sandy loam

E horizon:
Hue—7.5YR or 10YR
Value—4 or 5
Chroma—2 to 4
Texture—sandy loam, fine sandy loam, or very fine sandy loam

Bt horizon:
Hue—5YR or 7.5YR
Value—3 to 5
Chroma—3 to 6
Texture—sandy loam, loam, or fine sandy loam

BC horizon:
Hue—2.5YR or 7.5YR
Value—3 to 5
Chroma—3 or 4
Texture—fine sandy loam or sandy loam

Cd horizon:
Hue—5YR or 2.5YR
Value—3 to 5
Chroma—3 or 4
Texture—sandy loam or fine sandy loam or the gravelly analogs of those textures

Mora Series

Depth class: Moderately deep over dense glacial till

Drainage class: Moderately well drained

Permeability: Moderately rapid or moderate in the upper part; very slow in the lower part

Landform: Ground moraines

Parent material: Glacial till

Slope range: 1 to 3 percent

Taxonomic class: Coarse-loamy, mixed Aquic Eutroboralfs

Typical Pedon

Mora loam, very stony, 325 feet south and 2,300 feet east of the northwest corner of sec. 5, T. 37 N., R. 20 W.

A—0 to 4 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine roots; about 5 percent gravel and 5 percent cobbles; slightly acid; clear wavy boundary.

E—4 to 12 inches; dark brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; few fine roots; about 5 percent gravel and 5 percent cobbles; slightly acid; clear wavy boundary.

Bt—12 to 30 inches; dark brown (7.5YR 4/4) sandy loam; few fine prominent reddish gray (5YR 5/2) mottles; weak fine subangular blocky structure; friable; few fine roots; few faint dark brown (7.5YR 3/4) clay films on faces of peds; about 10 percent gravel; moderately acid; gradual wavy boundary.

BC—30 to 50 inches; reddish brown (5YR 5/4) sandy loam; few medium distinct reddish gray (5YR 5/2) mottles; weak fine subangular blocky structure; firm; few fine roots; about 10 percent gravel; moderately acid; gradual wavy boundary.

Cd—50 to 60 inches; reddish brown (5YR 4/4) sandy loam; few medium distinct reddish gray (5YR 5/2) mottles; massive; very firm; about 10 percent gravel; moderately acid.

Range in Characteristics

Depth to dense till: 40 to 50 inches

Content of rock fragments: 1 to 15 percent throughout the profile

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

E horizon:
Hue—10YR
Value—4 or 5
Chroma—2 to 4
Texture—loam, fine sandy loam, or sandy loam

Bt horizon:
Hue—5YR or 7.5YR
Value—4 or 5
Chroma—3 to 6
Texture—sandy loam or fine sandy loam

BC horizon:
Hue—5YR or 2.5YR
Value—3 to 5
Chroma—3 to 6
Texture—sandy loam or fine sandy loam

Cd horizon:
Hue—5YR or 2.5YR

Value—3 or 4
Chroma—3 to 6
Texture—sandy loam, fine sandy loam, or the gravelly analogs of those textures

Nebish Series

Depth class: Very deep
Drainage class: Well drained
Permeability: Moderate
Landform: Ground moraines
Parent material: Glacial till
Slope range: 2 to 40 percent
Taxonomic class: Fine-loamy, mixed Typic Eutroboralfs

Typical Pedon

Nebish loam, 2 to 6 percent slopes, 1,050 feet south and 1,400 feet west of the northeast corner of sec. 19, T. 34 N., R. 20 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; common fine roots; about 5 percent gravel; slightly acid; abrupt smooth boundary.

Bt1—10 to 21 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium angular blocky structure; firm; common fine roots; common faint dark brown (10YR 4/3) clay films on faces of peds; about 2 percent gravel; slightly acid; gradual wavy boundary.

Bt2—21 to 40 inches; yellowish brown (10YR 5/4) loam; weak medium subangular blocky structure; friable; few fine roots; common faint dark yellowish brown (10YR 4/4) clay films on faces of peds; about 5 percent gravel; neutral; gradual wavy boundary.

C—40 to 60 inches; yellowish brown (10YR 5/4) loam; weak medium subangular blocky structure; friable; few fine roots; about 5 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 36 to 60 inches
Content of rock fragments: 2 to 10 percent throughout the profile
Other characteristics: An E horizon in some pedons

A horizon:
Hue—10YR
Value—2 to 5
Chroma—1 or 2
Texture—loam

Bt horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—3 or 4
Texture—clay loam or loam

C horizon:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—3 or 4
Texture—loam, clay loam, or sandy clay loam

Newson Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Moderately rapid in the upper part; rapid in the lower part
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Mixed, frigid Humaqueptic Psammaquents

Typical Pedon

Newson mucky loamy sand, 1,300 feet south and 450 feet west of the northeast corner of sec. 14, T. 35 N., R. 21 W.

Ap—0 to 8 inches; black (2.5Y 2/1) mucky loamy sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; common fine roots; strongly acid; abrupt smooth boundary.

Bg1—8 to 18 inches; dark grayish brown (2.5Y 4/2) loamy sand; few medium prominent dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; very friable; common fine roots; strongly acid; clear wavy boundary.

Bg2—18 to 26 inches; dark grayish brown (2.5Y 4/2) loamy sand; common medium prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; very friable; common fine roots; strongly acid; clear wavy boundary.

BCg—26 to 32 inches; grayish brown (10YR 5/2) loamy sand; common medium prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; very friable; few fine roots; strongly acid; clear wavy boundary.

Cg1—32 to 48 inches; dark grayish brown (10YR 4/2) sand; common fine prominent dark brown (7.5YR 4/4) mottles; single grain; loose; few fine roots; strongly acid; clear wavy boundary.

Cg2—48 to 60 inches; dark brown (7.5YR 4/4) sand; common medium distinct strong brown (7.5YR 4/6) mottles; single grain; loose; few fine roots; about 10 percent gravel; strongly acid.

Range in Characteristics

Content of rock fragments: 0 to 15 percent throughout the profile

A horizon:
Hue—2.5Y or 10YR
Value—2 or 3
Chroma—1 to 3
Texture—mucky loamy sand

Bg horizon:
Hue—10YR or 2.5Y
Value—4 to 7
Chroma—1 or 2
Texture—loamy sand or sand

BC horizon:
Colors and textures similar to those of the Bg and Cg horizons

Cg horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 to 7
Chroma—1 to 4
Texture—loamy sand or sand

Novak Series

Depth class: Moderately deep over coarse textured material
Drainage class: Well drained
Permeability: Moderate in the upper part; rapid and very rapid in the lower part
Landform: Outwash plains
Parent material: Silty sediments overlying glacial outwash
Slope range: 0 to 6 percent
Taxonomic class: Fine-silty over sandy or sandy-skeletal, mixed Mollic Eutroboralfs

Typical Pedon

Novak silt loam, 0 to 6 percent slopes, 2,300 feet north and 200 feet east of the southwest corner of sec. 18, T. 35 N., R. 19 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; common fine roots; slightly acid; abrupt smooth boundary.

E—8 to 13 inches; dark brown (10YR 4/3) silt loam; weak thin platy structure; very friable; common fine roots; slightly acid; clear wavy boundary.

E/B—13 to 17 inches; 70 percent dark brown (10YR 4/3) silt loam (E), 30 percent dark brown (7.5YR 4/4) silt loam (Bt); weak fine subangular blocky structure; friable; common fine roots; slightly acid; clear wavy boundary.

Bt1—17 to 34 inches; dark brown (7.5YR 4/4) silt loam; weak fine angular blocky structure; friable; common fine roots; common distinct dark yellowish brown (10YR 3/4) clay films on faces of peds; moderately acid; gradual irregular boundary.

2Bt2—34 to 38 inches; dark brown (7.5YR 4/4) sandy loam; weak fine subangular blocky structure; friable; few fine roots; few distinct dark yellowish brown (10YR 4/3) clay films on faces of peds; slightly acid; clear wavy boundary.

2C—38 to 60 inches; brown (10YR 5/3) sand; single grain; loose; few fine roots; slight effervescence; slightly alkaline.

Range in Characteristics

Thickness of the mantle: 20 to 40 inches
Content of rock fragments: 5 to 35 percent in the underlying material

A horizon:
Hue—10YR or 7.5YR
Value—2 or 3
Chroma—1 to 3
Texture—silt loam

E horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—2 or 3
Texture—silt loam

E/B horizon:
Colors and textures similar to those of the E and Bt horizons

Bt horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—3 or 4
Texture—silt loam or silty clay loam

2Bt horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 to 6
Chroma—3 to 6
Texture—loam or sandy loam

2C horizon:
Hue—10YR, 7.5YR, or 5YR
Value—4 to 6
Chroma—3 to 6
Texture—sand, gravelly sand, coarse sand, or gravelly coarse sand

Nymore Series

Depth class: Very deep
Drainage class: Excessively drained

Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 1 to 25 percent
Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Nymore loamy sand, 1 to 6 percent slopes, 2,000 feet south and 100 feet east of the northwest corner of sec. 25, T. 36 N., R. 21 W.

Ap—0 to 7 inches; dark brown (7.5YR 3/2) loamy sand, brown (7.5YR 4/2) dry; single grain; loose; few fine roots; strongly acid; abrupt smooth boundary.

Bw—7 to 27 inches; reddish brown (5YR 4/3) loamy sand; single grain; loose; few fine roots; strongly acid; clear wavy boundary.

C—27 to 60 inches; brown (7.5YR 5/4) sand; single grain; loose; few fine roots; strongly acid.

Range in Characteristics

Content of rock fragments: 0 to 10 percent throughout the profile

A horizon:
Hue—10YR or 7.5YR
Value—2 or 3
Chroma—1 or 2
Texture—loamy sand

Bw horizon:
Hue—5YR to 10YR
Value—3 to 5
Chroma—3 to 6
Texture—loamy sand, loamy coarse sand, coarse sand, or sand

C horizon:
Hue—7.5YR or 10YR
Value—5 or 6
Chroma—3 to 6
Texture—sand or coarse sand

Plainbo Series

Depth class: Moderately deep
Drainage class: Excessively drained
Permeability: Rapid
Landform: Stream terraces
Parent material: Glacial outwash overlying bedrock
Slope range: 12 to 40 percent
Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Plainbo loamy sand, in an area of Plainbo-Rock outcrop complex, 12 to 40 percent slopes; 500 feet north and 1,600 feet west of the southeast corner of sec. 25, T. 34 N., R. 19 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) loamy sand; weak fine subangular blocky structure; very friable; few fine roots; about 2 percent gravel; slightly acid; clear wavy boundary.

Bw—5 to 23 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; few fine roots; about 2 percent gravel; slightly acid; abrupt wavy boundary.

2R—23 inches; very dark gray (N 3/0) basalt.

Range in Characteristics

Depth to bedrock: 20 to 40 inches
Content of rock fragments: 1 to 10 percent in the mantle

A horizon:
Hue—10YR
Value—3 or 4
Chroma—1 to 3
Texture—loamy sand

Bw horizon:
Hue—10YR or 7.5YR
Value—4 to 6
Chroma—3 to 6
Texture—loamy sand or sand

Pomroy Series

Depth class: Moderately deep over dense glacial till
Drainage class: Well drained
Permeability: Rapid in the upper part; slow or very slow in the lower part
Landform: Ground moraines
Parent material: Glacial outwash and the underlying glacial till
Slope range: 1 to 12 percent
Taxonomic class: Loamy, mixed Arenic Eutroboralfs

Typical Pedon

Pomroy loamy fine sand, 1 to 6 percent slopes, 2,200 feet south and 50 feet east of the northwest corner of sec. 30, T. 37 N., R. 20 W.

A—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; common fine roots; moderately acid; clear wavy boundary.

E—9 to 20 inches; dark brown (7.5YR 4/2) loamy fine sand; weak fine subangular blocky structure: very friable; common fine roots; moderately acid; clear wavy boundary.

2Bt—20 to 40 inches; reddish brown (5YR 4/4) sandy

loam; few fine distinct yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; firm; few fine roots; few distinct dark brown (7.5YR 3/4) clay films on faces of peds; about 8 percent gravel; slightly acid; gradual wavy boundary.

2Cd—40 to 60 inches; reddish brown (5YR 4/4) sandy loam; massive; very firm; about 8 percent gravel; slightly acid.

Range in Characteristics

Thickness of the sandy mantle: 20 to 40 inches
Depth to dense till: 40 to 50 inches
Content of rock fragments: 0 to 2 percent in the upper part; 5 to 20 percent in the underlying glacial till

A horizon:
Hue—10YR
Value—2 to 4
Chroma—1 to 3
Texture—loamy fine sand

E horizon:
Hue—7.5YR or 10YR
Value—4 or 5
Chroma—2 or 3
Texture—loamy fine sand, fine sand, or sand

2Bt horizon:
Hue—7.5YR or 5YR
Value—4 or 5
Chroma—3 or 4
Texture—sandy loam or fine sandy loam

2Cd horizon:
Hue—5YR or 7.5YR
Value—3 to 5
Chroma—3 to 6
Texture—sandy loam or fine sandy loam

Prebish Series

Depth class: Deep over dense glacial till
Drainage class: Very poorly drained
Permeability: Moderately rapid to moderately slow in the upper part; very slow in the lower part
Landform: Ground moraines
Parent material: Local alluvium overlying glacial till
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy, mixed, frigid Typic Haplaquolls

Typical Pedon

Prebish sandy loam, 2,000 feet north and 1,750 feet west of the southeast corner of sec. 6, T. 37 N., R. 20 W.

A—0 to 10 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; common fine roots; about 3 percent gravel and 5 percent cobbles; moderately acid; clear smooth boundary.

Bg1—10 to 18 inches; dark grayish brown (2.5Y 4/2) sandy loam; common medium prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common fine roots; about 2 percent gravel; moderately acid; gradual wavy boundary.

Bg2—18 to 42 inches; reddish brown (5YR 4/3) sandy loam; common fine distinct brown (7.5YR 5/2) mottles; weak medium subangular blocky structure; friable; common fine roots; about 8 percent gravel; moderately acid; gradual wavy boundary.

2Cd1—42 to 50 inches; reddish brown (5YR 4/4) sandy loam; common fine distinct reddish gray (5YR 5/2) mottles; massive; very firm; few fine roots; about 6 percent gravel; moderately acid; gradual wavy boundary.

2Cd2—50 to 60 inches; reddish brown (5YR 4/4) sandy loam; massive; very firm; few fine roots; about 6 percent gravel; moderately acid.

Range in Characteristics

Depth to dense till: 40 to 60 inches
Thickness of the mollic epipedon: 10 to 20 inches
Content of rock fragments: 2 to 8 percent in the upper part; 5 to 15 percent in the underlying dense glacial till

A horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—sandy loam

Bg1 horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 to 6
Chroma—1 or 2
Texture—sandy loam, coarse sandy loam, loam, or fine sandy loam

Bg2 horizon:
Hue—5YR, 7.5YR, 10YR, or 2.5Y
Value—4 or 5
Chroma—1 to 3
Texture—sandy loam, coarse sandy loam, fine sandy loam, or loam

2Cd horizon:
Hue—5YR or 7.5YR
Value—3 to 5
Chroma—3 to 6
Texture—sandy loam, coarse sandy loam, or fine sandy loam

Rondeau Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid in the upper part; slow or very slow in the lower part
Landform: Ground moraines
Parent material: Highly decomposed herbaceous plants and the underlying limnic material
Slope range: 0 to 1 percent
Taxonomic class: Marly, euic Limnic Borosaprists

Typical Pedon

Rondeau muck, 2,600 feet south and 300 feet west of the northeast corner of sec. 35, T. 37 N., R. 21 W.

Oa1—0 to 8 inches; muck, very dark grayish brown (10YR 3/2) broken face, black (10YR 2/1) rubbed; 10 percent fiber, 5 percent rubbed; weak fine subangular blocky structure; very friable; slight effervescence; slightly alkaline; gradual wavy boundary.

Oa2—8 to 16 inches; muck, black (10YR 2/1) broken face and rubbed; 10 percent fiber, 5 percent rubbed; weak fine subangular blocky structure; very friable; slight effervescence; slightly alkaline; gradual wavy boundary.

Oa3—16 to 29 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed; 10 percent fiber, 5 percent rubbed; weak fine subangular blocky structure; very friable; slight effervescence; slightly alkaline; clear wavy boundary.

Oe—29 to 39 inches; mucky peat, very dark grayish brown (10YR 3/2) broken face, black (10YR 2/1) rubbed; 45 percent fiber, 10 percent rubbed; weak fine subangular blocky structure; very friable; slight effervescence; slightly alkaline; abrupt wavy boundary.

Cg—39 to 60 inches; light gray (10YR 7/2) marl; massive; friable; violent effervescence; moderately alkaline.

Range in Characteristics

Thickness of the organic material: 16 to 51 inches
Depth to marl: 16 to 51 inches

Oa horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—muck

Oe horizon:
Hue—10YR
Value—2 to 4
Chroma—2 or 3
Texture—mucky peat

Cg horizon:
Hue—10YR, 2.5Y, 5Y
Value—5 to 7
Chroma—1 or 2
Texture—marl

Ronneby Series

Depth class: Moderately deep over dense glacial till
Drainage class: Somewhat poorly drained
Permeability: Moderately rapid or moderate in the upper part; very slow in the lower part
Landform: Ground moraines
Parent material: Glacial till
Slope range: 0 to 2 percent
Taxonomic class: Coarse-loamy, mixed, frigid Udollic Ochraqualfs

Typical Pedon

Ronneby loam, extremely stony, 185 feet south and 1,200 feet west of the northeast corner of sec. 1, T. 37 N., R. 21 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; common fine roots; about 2 percent gravel; slightly acid; clear wavy boundary.

E—7 to 19 inches; dark grayish brown (10YR 4/2) sandy loam; common fine prominent brown (7.5YR 5/4) mottles; weak thin platy structure; friable; few fine roots; about 5 percent gravel and 4 percent cobbles; slightly acid; clear wavy boundary.

Bt—19 to 35 inches; reddish gray (5YR 5/2) sandy loam; common fine distinct reddish brown (5YR 4/4) mottles; weak medium subangular blocky structure; friable; few fine roots; few distinct dark reddish gray (5YR 4/2) clay films on faces of peds; about 5 percent gravel; slightly acid; gradual wavy boundary.

BC—35 to 44 inches; reddish brown (5YR 4/4) sandy loam; few medium prominent grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; firm; few fine roots; about 5 percent gravel; neutral; gradual wavy boundary.

Cd—44 to 60 inches; reddish brown (5YR 4/4) sandy loam; few medium prominent grayish brown (10YR 5/2) mottles; massive; very firm; about 5 percent gravel; neutral.

Range in Characteristics

Depth to dense glacial till: 20 to 40 inches
Content of rock fragments: 1 to 15 percent throughout the profile

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

E horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—1 or 2
Texture—sandy loam, fine sandy loam, very fine sandy loam, or loam

Bt horizon:
Hue—5YR or 7.5YR
Value—4 or 5
Chroma—2 to 4
Texture—sandy loam, loam, or fine sandy loam

BC horizon:
Hue—5YR or 2.5YR
Value—3 or 4
Chroma—2 to 4
Texture—fine sandy loam or sandy loam

Cd horizon:
Hue—5YR or 2.5YR
Value—3 or 4
Chroma—3 or 4
Texture—sandy loam or fine sandy loam

Sartell Series

Depth class: Very deep
Drainage class: Excessively drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash, eolian sediments, or both
Slope range: 1 to 25 percent
Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Sartell fine sand, 1 to 6 percent slopes, 2,400 feet north and 1,000 feet west of the southeast corner of sec. 26, T. 34 N., R. 21 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) fine sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; very friable; common fine roots; strongly acid; abrupt smooth boundary.

Bw—8 to 25 inches; dark brown (10YR 4/3) fine sand; weak medium subangular blocky structure; very friable; few fine roots; strongly acid; gradual wavy boundary.

C—25 to 60 inches; brown (10YR 5/3) fine sand; single grain; loose; few fine roots; slightly acid.

Range in Characteristics

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—fine sand

Bw horizon:
Hue—10YR
Value—3 to 5
Chroma—3 to 5
Texture—fine sand or sand

C horizon:
Hue—10YR
Value—5 to 7
Chroma—2 to 6
Texture—fine sand or sand

Seelyeville Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid
Landform: Ground moraines and outwash plains
Parent material: Highly decomposed herbaceous plants
Slope range: 0 to 1 percent
Taxonomic class: Euic Typic Borosaprists

Typical Pedon

Seelyeville muck, 175 feet north and 2,100 feet west of the southeast corner of sec. 33, T. 36 N., R. 21 W.

Oap—0 to 10 inches; muck, black (10YR 2/1) broken face and rubbed; about 20 percent fibers, about 2 percent rubbed; weak medium subangular blocky structure; primarily herbaceous fibers; strongly acid; abrupt wavy boundary.

Oa—10 to 32 inches; muck, black (10YR 2/1) broken face and rubbed; about 30 percent fibers, about 5 percent rubbed; weak medium subangular blocky structure; primarily herbaceous fibers; strongly acid; gradual wavy boundary.

Oe—32 to 36 inches; mucky peat, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed; 40 percent fibers, about 20 percent rubbed; weak medium subangular blocky structure; primarily herbaceous fibers; strongly acid; gradual wavy boundary.

O'a—36 to 60 inches; muck, black (10YR 2/1) broken face and rubbed; 30 percent fiber, about 10 percent rubbed; weak medium subangular blocky structure; primarily herbaceous fibers; strongly acid.

Range in Characteristics

Thickness of the organic material: More than 51 inches

Oa horizon:
Hue—10YR or 7.5YR
Value—2
Chroma—1 or 2
Texture—muck

Oe horizon:
Hue—10YR
Value—2 or 3
Chroma—2 or 3
Texture—mucky peat

Siren Series

Depth class: Very deep
Drainage class: Somewhat poorly drained
Permeability: Moderate in the upper part; moderately slow or slow in the lower part
Landform: Isolated glacial lake plains or stream terraces
Parent material: Loamy sediments overlying lacustrine material
Slope range: 0 to 3 percent
Taxonomic class: Fine, mixed Glossaquic Eutroboralfs

Typical Pedon

Siren silt loam, 2,300 feet north and 1,200 feet west of the southeast corner of sec. 24, T. 36 N., R. 21 W.

A—0 to 2 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; common fine roots; moderately acid; abrupt wavy boundary.

E—2 to 4 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium platy structure; friable; few fine roots; moderately acid; abrupt wavy boundary.

E/B—4 to 6 inches; about 60 percent grayish brown (10YR 5/2) silt loam (E), 40 percent reddish brown (5YR 4/4) silty clay loam (Bt); weak fine prismatic structure parting to weak very fine subangular blocky; firm; few fine roots; strongly acid; abrupt wavy boundary.

2Bt1—6 to 11 inches; reddish brown (5YR 4/4) silty clay loam; common distinct dark reddish brown (5YR 3/2) mottles; weak medium angular blocky structure; firm; few fine roots; common faint reddish brown (5YR 4/3) clay films on faces of peds; very strongly acid; clear wavy boundary.

2Bt2—11 to 34 inches; reddish brown (5YR 4/4) silty clay; strong fine angular blocky structure; firm; few fine roots; common thin reddish brown (5YR 4/3) clay films on faces of peds; slightly acid; clear wavy boundary.

2C1—34 to 42 inches; yellowish red (5YR 4/6) silty clay loam that has varves of reddish brown (5YR 4/3) silt one-fourth to one-half inch thick; moderate medium and thick platy varving; very friable; few fine roots; neutral; clear wavy boundary.

2C2—42 to 60 inches; yellowish red (5YR 4/6) silty clay loam that has varves of reddish brown (5YR 4/3) silt one-fourth to one-half inch thick; moderate medium and thick platy varving; very friable; few fine roots; strong effervescence; slightly alkaline.

Range in Characteristics

Thickness of the loamy mantle: 0 to 24 inches
Content of rock fragments: 0 to 5 percent in the loamy mantle

A horizon:
Hue—10YR or 7.5YR
Value—2 to 4
Chroma—1 to 3
Texture—silt loam

E horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—2 or 3
Texture—silt loam, fine sandy loam, or sandy loam

E/B horizon:
Colors and textures similar to those of the E and 2Bt horizons

2Bt horizon:
Hue—5YR or 7.5YR
Value—4 to 6
Chroma—3 to 6
Texture—silty clay, silty clay loam, or clay

2C horizon:
Hue—5YR or 7.5YR
Value—4 to 6
Chroma—3 to 6
Texture—silty clay loam, silty clay, or clay

Soderville Series

Depth class: Very deep
Drainage class: Somewhat poorly drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash, eolian sediments, or both
Slope range: 0 to 2 percent
Taxonomic class: Sandy, mixed Aquic Glossoboralfs

Typical Pedon

Soderville loamy fine sand, 1,450 feet north and 200

feet west of the southeast corner of sec. 32, T. 36 N., R. 22 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; very friable; many fine roots; moderately acid; abrupt smooth boundary.

E—9 to 32 inches; dark brown (10YR 4/3) fine sand; few fine distinct dark brown (7.5YR 4/4) mottles; single grain; loose; many fine roots; moderately acid; clear wavy boundary.

Bt1—32 to 37 inches; yellowish brown (10YR 5/4) loamy fine sand; common medium distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; very friable; common fine roots; clay bridges between sand grains; strongly acid; gradual wavy boundary.

Bt2—37 to 45 inches; dark yellowish brown (10YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; common fine roots; clay bridges between sand grains; strongly acid; clear wavy boundary.

C1—45 to 52 inches; brown (10YR 5/3) sand; few fine faint dark grayish brown (10YR 4/2) mottles; single grain; loose; few fine roots; strongly acid; clear wavy boundary.

C2—52 to 60 inches; dark yellowish brown (10YR 4/4) loamy sand; few fine distinct grayish brown (10YR 5/2) mottles; massive; very friable; few fine roots; strongly acid.

Range in Characteristics

A horizon:
Hue—10YR
Value—3 or 4
Chroma—1 or 2
Texture—loamy fine sand

E horizon:
Hue—10YR
Value—4 to 7
Chroma—2 or 3
Texture—fine sand or loamy fine sand

Bt horizon:
Hue—10YR or 5YR
Value—4 to 7
Chroma—3 or 4
Texture—loamy fine sand or loamy sand

C horizon:
Hue—10YR or 7.5YR
Value—4 to 7
Chroma—3 to 5
Texture—sand, loamy sand, or fine sand

Talmoon Series

Depth class: Very deep
Drainage class: Poorly drained
Permeability: Moderate in the upper part; moderately slow in the lower part
Landform: Ground moraines
Parent material: Glacial till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, frigid Mollic Ochraqualfs

Typical Pedon

Talmoon loam, 2,550 feet north and 1,100 feet west of the southeast corner of sec. 12, T. 34 N., R. 20 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine roots; about 2 percent gravel; slightly acid; abrupt smooth boundary.

Eg—9 to 12 inches; grayish brown (2.5Y 5/2) silt loam; common fine prominent brown (7.5YR 5/4) mottles; weak medium platy structure parting to weak very fine subangular blocky; friable; common fine roots; moderately acid; clear wavy boundary.

Btg—12 to 24 inches; grayish brown (2.5Y 5/2) clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; moderate fine angular blocky structure; firm; few fine roots; few faint dark grayish brown (2.5Y 4/2) clay films on faces of peds; about 2 percent gravel; moderately acid; gradual wavy boundary.

BC—24 to 44 inches; grayish brown (2.5Y 5/2) loam; common medium prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; about 3 percent gravel; moderately acid; gradual wavy boundary.

Cg—44 to 60 inches; grayish brown (2.5Y 5/2) loam; many large prominent yellowish brown (10YR 5/4) mottles; massive; friable; few fine roots; about 6 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 18 to 48 inches
Content of rock fragments: 1 to 10 percent throughout the profile

A horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 to 2
Texture—loam

Eg horizon:
Hue—10YR to 5Y
Value—4 to 6
Chroma—1 or 2
Texture—silt loam, loam, fine sandy loam, sandy loam, or very fine sandy loam

Btg horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 or 2
Texture—clay loam, sandy clay loam, or loam

BC horizon:
Colors and textures similar to those of the Btg and Cg horizons

Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—loam, clay loam, or sandy clay loam

Warman Series

Depth class: Moderately deep over coarse textured material
Drainage class: Very poorly drained
Permeability: Moderate or moderately rapid in the upper part; rapid or very rapid in the lower part
Landform: Outwash plains
Parent material: Loamy mantle overlying glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy over sandy or sandy-skeletal, mixed, frigid Typic Haplaquolls

Typical Pedon

Warman loam, 900 feet north and 500 feet east of the southwest corner of sec. 13, T. 35 N., R. 21 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common fine roots; moderately acid; clear smooth boundary.

Bg1—10 to 14 inches; dark brown (7.5YR 4/2) loam; common fine prominent yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; friable; common fine roots; moderately acid; gradual wavy boundary.

Bg2—14 to 34 inches; brown (7.5YR 5/2) loam; common fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; common fine roots; moderately acid; gradual wavy boundary.

2Cg—34 to 60 inches; brown (7.5YR 5/2) sand; few fine distinct strong brown (7.5YR 5/6) mottles; single grain; loose; very friable; few fine roots; neutral.

Range in Characteristics

Depth to coarse textured material: 20 to 40 inches
Thickness of the mollic epipedon: 8 to 24 inches
Content of rock fragments: 0 to 10 percent in the mantle; 5 to 30 percent in the underlying material

A horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—loam

Bg horizon:
Hue—7.5YR, 10YR, or 2.5Y
Value—4 or 5
Chroma—1 or 2
Texture—loam, very fine sandy loam, or fine sandy loam

2Cg horizon:
Hue—5YR or 7.5YR
Value—3 to 6
Chroma—2 to 4
Texture—sand, gravelly coarse sand, or coarse sand

Zimmerman Series

Depth class: Very deep
Drainage class: Excessively drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Glacial outwash, eolian sediments, or both
Slope range: 1 to 12 percent
Taxonomic class: Mixed, frigid Alfic Udipsamments

Typical Pedon

Zimmerman loamy fine sand, 1 to 6 percent slopes, 2,000 feet south and 1,400 feet east of the northwest corner of sec. 27, T. 34 N., R. 21 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; few fine roots; slightly acid; abrupt smooth boundary.

Bw—8 to 20 inches; dark yellowish brown (10YR 4/4) fine sand; weak fine subangular blocky structure; very friable; few fine roots; slightly acid; clear wavy boundary.

E—20 to 44 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; few fine roots; slightly acid; gradual wavy boundary.

E and Bt—44 to 60 inches; yellowish brown (10YR 5/4) fine sand (E); single grain; loose; lamellae and

bands of dark yellowish brown (10YR 4/4) loamy fine sand (Bt); weak fine subangular blocky structure; very friable; few fine roots; slightly acid.

Range in Characteristics

Content of rock fragments: 0 to 5 percent throughout the profile

Other characteristics: A C horizon in some pedons

A horizon:
- Hue—10YR or neutral
- Value—2 or 3
- Chroma—0 to 2
- Texture—loamy fine sand

Bw horizon:
- Hue—10YR
- Value—4 to 6
- Chroma—3 to 6
- Texture—loamy fine sand or fine sand

E horizon:
- Hue—10YR
- Value—4 to 7
- Chroma—2 to 4
- Texture—fine sand or loamy fine sand

E and Bt horizon:
- Colors and textures similar to those of the E horizon and the Bt horizon

Bt horizon (only in some pedons):
- Hue—10YR or 7.5YR
- Value—3 to 5
- Chroma—2 to 6
- Texture—loamy fine sand, fine sand, very fine sand, loamy very fine sand, or fine sandy loam

Formation of the Soils

Soils form as a result of the interaction of five major factors. These factors are parent material, relief, plant and animal life, climate, and time. Climate and plant and animal life are active factors of soil formation. They act on the parent material and slowly change it into soil that has distinct horizons. The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the physical medium in which a soil forms. The source of the diverse soils in Chisago County can be traced to the period of glacial activity that ended approximately 10,000 years ago. During that period most of the county was influenced by two glacial flows. The first was the Superior Lobe of the Wisconsin glaciation. It consisted of red glacial till that came from Glacial Lake Duluth, which was located where Lake Superior is today. Milaca, Mora, and Ronneby soils formed in material deposited by this flow. The second glacial flow was the Grantsburg Sublobe (once known as the Chisago Sublobe) of the Des Moines Lobe of the Wisconsin glaciation. It extended from the west and ended at Grantsburg, Wisconsin. The glacier deposited gray glacial till over the red glacial till. Cushing, Nebish, and Alstad soils formed in this material *(9, 10, 11)*.

As the Grantsburg Sublobe retreated to the west, the meltwater from the glacial ice deposited gray, sandy outwash. As a result of this deposit, the Anoka Sand Plain was formed. This sand plain, which is in the central part of the county, includes Zimmerman, Sartell, and Lino soils. It divides the county and separates the gray glacial till into two areas. One area is in the northwestern part of the county, and the other is in the southeastern part. The gray glacial till underlies the Anoka Sand Plain at a depth of 30 to 50 feet *(9, 10, 11)*.

Another geologic area is along the St. Croix River. As Glacial Lake Duluth rapidly drained, the enormous flow of water washed out the gray till and outwash. This scouring exposed the older underlying red glacial till of the Superior Lobe in some areas and redeposited red glacial material as outwash in others. The decreasing outwash flow from Glacial Lake Duluth and the subsequent decrease in the volume of water in the St. Croix River resulted in the formation of isolated oxbow lakes where the main river channel originally flowed. These oxbow lakes eventually became shallower and thickly vegetated, resulting in the formation of large organic bogs. Seelyeville, Cathro, Markey, and Rondeau soils formed in this area (fig. 11).

Relief

Relief affects drainage, erosion, soil moisture, and soil temperature. It also influences weathering of the parent material. Slope affects soil formation by influencing runoff and surface and subsurface drainage characteristics. Wet, poorly drained soils form slowly because of their saturated condition, which slows or stops microbial and chemical action. Talmoon and Bluffton soils, which are in concave landscape positions, are examples. Soils in convex positions have a warmer, drier environment that encourages chemical and microbial action and accelerates the development of distinct profiles. Cushing and Milaca soils are examples of soils in convex landscape positions.

Soils in the steeper areas that drain too quickly or that have excessive runoff rates tend to form more slowly because of erosion, a low moisture supply, and little or no plant growth. Soils in gently sloping or nearly level areas generally have a higher degree of profile development. Beltrami and Alstad soils are examples.

Climate

Chisago County has a subhumid, continental climate characterized by hot summers and cold winters. The climate has a pronounced effect on soil formation.

Temperature affects the rate of soil formation by controlling the rate of microbial activity. As the temperature rises, microbial activity increases. This increased activity results in more rapid decomposition of

Figure 11.—An area of Seelyeville muck in an abandoned oxbow along the St. Croix River. This soil is used for sod and vegetable production.

organic material, which increases the availability of nutrients for plants. Cold temperatures slow the rate of microbial activity and can stop it altogether. Alternate periods of freezing and thawing influence the development of soil structure.

Moisture affects soil formation by its influence on the process of leaching material downward and carrying material upward through capillary action. In soils this process can be indicated by an increased concentration of clay in one horizon. Cushing and Nebish soils are examples of soils in which this process has taken place. Moisture also affects soil formation by controlling the air available in the pore spaces. Excessive rainfall, ponding, or slow permeability can create an anaerobic condition, which results in the formation of a different kind of soil than is formed under a consistently aerobic condition. Sartell soils formed under aerobic conditions, and Isanti soils formed under anaerobic conditions.

Temperature and moisture also affect soil formation through their influence on the type of vegetation that grows in an area. For example, the micro-climate created by different aspects of slope can influence the

growth of grasses or trees. Trees grow best on wetter, cooler sites, and grasses grow best on drier, warmer sites.

Time

Time is the factor that enables all of the other factors of soil formation to function. The soils in Chisago County formed in glacial material, which weathered and began to form soil profiles. About 10,000 years was required for the soils in the county to develop distinct profiles.

Any change in climate, drainage, or vegetation affects the type of soil profile that forms and the rate of its formation. Soils on flood plains, such as Fordum and Caryville soils, are generally the least developed because of the frequent deposition of new material. Soils in eroded areas have little or no topsoil. In some areas, topsoil that took thousands of years to develop has been lost within a period of only a few years. The eroded soil material is deposited elsewhere as sediment and can affect water quality.

Plants and Animals

Plants, animals, and micro-organisms contribute to the formation of soil. If all other soil-forming factors were equal, a change in the type of vegetation on a soil would change the way the soil forms. Most of the soils in Chisago County formed under a forest environment.

In a prairie grass environment, the constant death and regrowth of the dense grass root system result in the formation of a thick, dark surface layer. In a forest, however, the litter remains on the surface of the soil. It forms organic acids as it decomposes. The acids dissolve minerals in the topsoil, and the dissolved minerals are carried downward to form the distinctive horizons of a forested soil.

The burrowing of small animals or of worms and ants mixes the soil and can accelerate soil formation by providing passageways for roots, nutrients, water, and air. Micro-organisms in the soil decompose roots and surface litter. They return nutrients to the soil through their waste products and through the recycling of their bodies as they die. This recycling process maintains the level of nutrients in the soil.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Barrens. Areas of vegetation that occur along or adjacent to oak openings. Barrens are maintained with fire and provide a buffer between prairie and woodland. The vegetation in these areas is a mixture of tall grass prairie, hazel, rose, and herbs.

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by the wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil

in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness

markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of the material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by the wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Round wood. Wood in the round. Round-wood products include logs, bolts, and other round sections cut from growing stock trees, cull trees, or salvageable dead trees.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. The slope classes defined in this survey are:

Nearly level	0 to 2 percent
Gently sloping	2 to 6 percent
Gently undulating	2 to 6 percent (complex slopes)
Sloping	6 to 12 percent
Rolling	6 to 12 percent (complex slopes)
Moderately steep	12 to 18 percent
Steep	18 to 25 percent
Very steep	25 to 45 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind erosion and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be

further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material that is too thin for the specified use.

Till plain. An extensive area of nearly level to undulating soils underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-84 at Cambridge, Minnesota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	18.0	-1.8	8.1	43	-33	0	0.72	0.18	1.12	3	10.5
February----	25.5	5.1	15.3	49	-26	0	.68	.18	1.07	2	7.7
March-------	36.7	17.3	27.0	64	-16	0	1.28	.49	1.89	4	9.7
April-------	54.4	32.8	43.6	84	12	33	2.14	.86	3.17	5	2.3
May---------	67.9	44.6	56.3	90	25	227	3.33	1.90	4.47	7	.1
June--------	76.3	53.9	65.1	94	37	453	4.88	2.74	6.62	8	.0
July--------	81.6	59.0	70.3	96	44	629	3.87	2.05	5.30	6	.0
August------	78.9	56.6	67.8	94	40	552	4.28	2.29	5.83	7	.0
September---	68.4	46.7	57.6	90	27	236	3.12	1.34	4.59	6	.0
October-----	57.1	36.5	46.8	82	15	72	2.33	.56	3.65	5	.6
November----	39.1	21.9	30.5	65	-6	0	1.30	.40	1.96	3	5.0
December----	24.5	6.9	15.7	48	-27	0	.94	.26	1.49	3	9.5
Yearly:											
Average---	52.4	31.8	42.0	---	---	---	---	---	---	---	---
Extreme---	---	---	---	97	-33	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,202	28.87	22.61	34.80	59	45.4

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-84 at Cambridge, Minnesota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 29	May 12	May 20
2 years in 10 later than--	Apr. 24	May 7	May 16
5 years in 10 later than--	Apr. 16	Apr. 28	May 8
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 3	Sept. 22	Sept. 13
2 years in 10 earlier than--	Oct. 9	Sept. 27	Sept. 17
5 years in 10 earlier than--	Oct. 20	Oct. 8	Sept. 25

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-84 at Cambridge, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	169	141	124
8 years in 10	175	148	129
5 years in 10	186	162	139
2 years in 10	198	175	149
1 year in 10	204	182	154

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
40B	Nebish loam, 2 to 6 percent slopes	22,453	8.5
40C	Nebish loam, 6 to 12 percent slopes	7,547	2.8
40D	Nebish loam, 12 to 25 percent slopes	3,302	1.2
40F	Nebish loam, 25 to 40 percent slopes	2,642	1.0
75	Bluffton loam	12,358	4.6
119B	Pomroy loamy fine sand, 1 to 6 percent slopes	2,075	0.8
119C	Pomroy loamy fine sand, 6 to 12 percent slopes	283	0.1
155B	Chetek sandy loam, 1 to 6 percent slopes	3,113	1.2
155C	Chetek loam, 6 to 12 percent slopes	1,038	0.4
158B	Zimmerman loamy fine sand, 1 to 6 percent slopes	18,208	6.9
158C	Zimmerman loamy fine sand, 6 to 12 percent slopes	1,697	0.6
159B	Anoka loamy very fine sand, 1 to 6 percent slopes	2,736	1.0
159C	Anoka loamy fine sand, 6 to 12 percent slopes	566	0.2
161	Isanti loamy fine sand	7,830	3.0
162	Lino loamy fine sand	7,075	2.7
169B	Braham loamy fine sand, 2 to 6 percent slopes	6,320	2.4
169C	Braham loamy fine sand, 6 to 12 percent slopes	1,266	0.5
182	Halder sandy loam	660	0.2
204B	Cushing loam, 2 to 6 percent slopes	13,962	5.3
204C	Cushing loam, 6 to 12 percent slopes	5,377	2.0
204D	Cushing loam, 12 to 20 percent slopes	1,604	0.6
204F	Cushing loam, 20 to 35 percent slopes	755	0.3
207B	Nymore loamy sand, 1 to 6 percent slopes	8,491	3.2
207C	Nymore loamy sand, 6 to 12 percent slopes	660	0.2
207D	Nymore loamy sand, 12 to 18 percent slopes	755	0.3
207E	Nymore loamy sand, 18 to 25 percent slopes	1,038	0.4
265	Soderville loamy fine sand	1,038	0.4
274	Newson mucky loamy sand	1,320	0.5
292	Alstad loam	11,600	4.4
325	Prebish sandy loam	1,320	0.5
328B	Sartell fine sand, 1 to 6 percent slopes	8,208	3.1
328C	Sartell fine sand, 6 to 12 percent slopes	1,132	0.4
328D	Sartell fine sand, 12 to 25 percent slopes	1,132	0.4
337	Warman loam	1,600	0.6
346	Talmoon loam	20,331	7.6
454B	Mahtomedi loamy sand, 1 to 6 percent slopes	3,679	1.4
454C	Mahtomedi loamy sand, 6 to 12 percent slopes	1,038	0.4
454D	Mahtomedi loamy sand, 12 to 20 percent slopes	755	0.3
454F	Mahtomedi loamy sand, 20 to 35 percent slopes	849	0.3
540	Seelyeville muck	29,434	11.1
543	Markey muck	4,434	1.7
544	Cathro muck	4,717	1.8
545	Rondeau muck	377	0.1
565	Eckvoll loamy sand	1,792	0.7
676B	Kost loamy fine sand, 1 to 6 percent slopes	3,774	1.4
677	Siren silt loam	940	0.4
678	Beltrami loam, thick solum	8,679	3.2
682B	Milaca sandy loam, 2 to 6 percent slopes, very stony	940	0.4
682C	Milaca sandy loam, 6 to 12 percent slopes, very stony	280	0.1
682D	Milaca sandy loam, 12 to 18 percent slopes, very stony	470	0.2
682E	Milaca sandy loam, 18 to 25 percent slopes, very stony	189	0.1
717B	Novak silt loam, 0 to 6 percent slopes	470	0.2
722	Blomford loamy sand, lacustrine substratum	2,730	1.0
726	Kratka loamy fine sand, thick solum	1,790	0.7
792	Fordum sandy loam, frequently flooded	4,906	1.8
928B	Mahtomedi-Cushing complex, 2 to 6 percent slopes	1,220	0.5
928C	Mahtomedi-Cushing complex, 6 to 12 percent slopes	940	0.4
928D	Mahtomedi-Cushing complex, 12 to 20 percent slopes	850	0.3
1030	Udorthents-Pits, gravel, complex	940	0.4
1068	Caryville sandy loam, occasionally flooded	3,100	1.2
1069C	Fairport-Rock outcrop complex, 2 to 12 percent slopes	280	0.1

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
1070D	Plainbo-Rock outcrop complex, 12 to 40 percent slopes	755	0.3
1977	Mora loam, very stony	1,400	0.5
1980	Ronneby loam, extremely stony	1,980	0.7
	Total	265,200	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
40B	Nebish loam, 2 to 6 percent slopes
159B	Anoka loamy very fine sand, 1 to 6 percent slopes
182	Halder sandy loam (where drained)
204B	Cushing loam, 2 to 6 percent slopes
292	Alstad loam
346	Talmoon loam (where drained)
565	Eckvoll loamy sand
677	Siren silt loam (where drained)
678	Beltrami loam, thick solum
717B	Novak silt loam, 0 to 6 percent slopes

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Reed canarygrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
40B---------- Nebish	2e	110	18	35	75	4.6	5.5	---
40C---------- Nebish	3e	90	15	28	70	4.0	5.0	---
40D---------- Nebish	6e	---	---	---	60	2.5	3.9	---
40F---------- Nebish	7e	---	---	---	---	---	2.8	---
75---------- Bluffton	3w	80	13	24	60	---	---	6.0
119B---------- Pomroy	3s	65	11	20	55	3.0	4.2	---
119C---------- Pomroy	4s	50	10	---	50	2.5	3.2	---
155B---------- Chetek	3e	60	11	26	60	3.0	4.0	---
155C---------- Chetek	4e	55	10	22	55	2.5	3.0	---
158B---------- Zimmerman	4s	50	9	18	40	2.0	3.0	---
158C---------- Zimmerman	6s	---	---	---	---	1.6	2.6	---
159B---------- Anoka	3e	75	12	20	---	3.5	5.0	---
159C---------- Anoka	4e	55	9	15	---	3.0	4.5	---
161---------- Isanti	4w	45	10	15	50	---	---	5.0
162---------- Lino	4w	70	9	20	50	---	---	4.5
169B---------- Braham	3s	70	11	20	60	3.0	4.5	---
169C---------- Braham	4e	60	10	18	55	2.7	3.8	---
182---------- Halder	2w	75	14	20	65	4.0	5.0	---

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Reed canarygrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
204B---------- Cushing	2e	105	17	32	75	4.5	5.5	---
204C---------- Cushing	3e	85	14	27	70	4.0	5.0	---
204D---------- Cushing	4e	---	---	---	60	2.5	3.8	---
204F---------- Cushing	6e	---	---	---	---	---	2.5	---
207B---------- Nymore	4s	50	9	15	35	2.0	3.0	---
207C---------- Nymore	4s	---	---	---	35	1.5	2.5	---
207D---------- Nymore	6s	---	---	---	---	---	2.0	---
207E---------- Nymore	7s	---	---	---	---	---	1.5	---
265---------- Soderville	4w	65	10	22	50	3.0	4.5	---
274---------- Newson	4w	45	8	17	45	---	---	5.0
292---------- Alstad	1	115	20	38	80	5.0	6.0	---
325---------- Prebish	4w	60	10	20	55	---	---	5.0
328B---------- Sartell	4s	55	9	18	45	2.0	3.0	---
328C---------- Sartell	6s	---	---	---	---	1.6	2.7	---
328D---------- Sartell	7s	---	---	---	---	---	2.0	---
337---------- Warman	4w	55	10	---	60	---	---	5.0
346---------- Talmoon	2w	90	16	35	70	4.4	5.2	---
454B---------- Mahtomedi	4s	45	7	---	35	2.0	3.0	---
454C---------- Mahtomedi	4s	40	5	---	30	1.6	2.5	---
454D---------- Mahtomedi	6s	---	---	---	---	1.3	2.0	---

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Reed canarygrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
454F---------- Mahtomedi	7s	---	---	---	---	---	1.5	---
540---------- Seelyeville	4w	50	12	---	55	---	---	6.0
543---------- Markey	4w	50	12	---	55	---	---	6.0
544---------- Cathro	4w	50	12	---	55	---	---	6.0
545---------- Rondeau	4w	50	12	---	55	---	---	6.0
565---------- Eckvoll	3s	65	11	22	60	3.0	4.2	---
676B---------- Kost	4s	60	11	22	50	2.5	3.7	---
677---------- Siren	2w	70	12	---	70	3.5	5.0	---
678---------- Beltrami	1	115	20	38	80	5.0	6.0	---
682B, 682C------ Milaca	6s	---	---	---	---	---	5.0	---
682D, 682E------ Milaca	6s	---	---	---	---	---	4.4	---
717B---------- Novak	2e	85	13	27	75	3.8	5.2	---
722---------- Blomford	3w	65	10	20	60	---	---	5.0
726---------- Kratka	4w	---	---	---	50	---	---	6.0
792---------- Fordum	6w	---	---	---	---	---	---	4.5
928B----------		80	12	24	60	3.6	5.0	---
Mahtomedi------	4s							
Cushing--------	2e							
928C----------		65	9	18	50	3.2	4.5	---
Mahtomedi------	4s							
Cushing--------	3e							
928D----------		---	---	---	---	2.5	3.2	---
Mahtomedi------	6s							
Cushing--------	4e							
1030. Udorthents-Pits								

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Corn silage	Soybeans	Oats	Bromegrass-alfalfa hay	Bromegrass-alfalfa	Reed canarygrass
		Bu	Tons	Bu	Bu	Tons	AUM*	AUM*
1068---------- Caryville	3w	70	11	26	60	3.0	4.0	---
1069C----------		---	---	---	---	---	---	---
Fairport-------	7s							
Rock outcrop---	8s							
1070D----------		---	---	---	---	---	---	---
Plainbo--------	7s							
Rock outcrop---	8s							
1977---------- Mora	6s	---	---	---	---	---	6.5	---
1980---------- Ronneby	7s	---	---	---	---	---	---	4.0

* Animal unit month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
40B, 40C, 40D, 40F Nebish	---	Amur maple, redosier dogwood, Siberian peashrub, lilac.	Northern whitecedar, white spruce, eastern redcedar, Manchurian crabapple, blue spruce.	Eastern white pine, green ash, red pine, silver maple.	Eastern cottonwood.
75 Bluffton	---	Redosier dogwood, Siberian peashrub.	Tamarack, black ash, black spruce.	Golden willow, white willow, eastern cottonwood.	---
119B, 119C Pomroy	---	American cranberrybush, Siberian peashrub, Amur maple, lilac.	Russian-olive, red pine, blue spruce, white spruce.	Jack pine, green ash, eastern white pine.	Silver maple, eastern cottonwood.
155B, 155C Chetek	Lilac, Siberian peashrub, silver buffaloberry.	Eastern redcedar, Manchurian crabapple, Siberian crabapple.	Red pine, green ash, Russian-olive.	Eastern white pine, jack pine.	---
158B, 158C Zimmerman	Lilac, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, Siberian crabapple.	Red pine, Russian-olive, green ash.	Jack pine, eastern white pine.	---
159B, 159C Anoka	---	American cranberrybush, Siberian peashrub, lilac, Amur maple.	Russian-olive, blue spruce, red pine, white spruce.	Eastern white pine, jack pine, green ash.	Silver maple, eastern cottonwood.
161 Isanti	---	Redosier dogwood, Siberian peashrub.	Tamarack, black ash, black spruce.	Golden willow, white willow, eastern cottonwood.	---
162 Lino	---	Redosier dogwood, American cranberrybush, lilac, northern whitecedar.	White spruce, black spruce, eastern redcedar, Siberian crabapple.	Red pine, eastern white pine, jack pine, green ash.	Silver maple, eastern cottonwood.
169B, 169C Braham	---	Siberian peashrub, American cranberrybush, Amur maple, lilac.	Russian-olive, red pine, blue spruce, white spruce.	Jack pine, eastern white pine, green ash.	Silver maple, eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
182 Halder	---	Redosier dogwood, American cranberrybush, lilac, northern whitecedar.	White spruce, eastern redcedar, Siberian crabapple, black spruce.	Red pine, eastern white pine, jack pine.	Silver maple, eastern cottonwood.
204B, 204C, 204D, 204F Cushing	---	Redosier dogwood, Siberian peashrub, lilac, Amur maple.	Northern whitecedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine, silver maple.	Eastern cottonwood.
207B, 207C, 207D, 207E Nymore	Lilac, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, Siberian crabapple.	Red pine, Russian-olive, green ash.	Eastern white pine, jack pine.	---
265 Soderville	---	Redosier dogwood, American cranberrybush, lilac, northern whitecedar.	White spruce, black spruce, eastern redcedar, Siberian crabapple.	Red pine, eastern white pine, jack pine.	Silver maple, eastern cottonwood.
274 Newson	---	Siberian peashrub, redosier dogwood.	Tamarack, black ash, black spruce.	Golden willow, white willow, eastern cottonwood.	---
292 Alstad	---	Siberian peashrub, American cranberrybush, redosier dogwood, lilac.	Eastern redcedar, white spruce, black spruce, Siberian crabapple.	Jack pine, red pine, eastern white pine, green ash.	Silver maple, eastern cottonwood.
325 Prebish	---	Redosier dogwood, Siberian peashrub.	Tamarack, black ash, black spruce, green ash.	Golden willow, white willow, eastern cottonwood.	---
328B, 328C, 328D Sartell	Lilac, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, Siberian crabapple.	Red pine, green ash, Russian-olive.	Jack pine, eastern white pine.	---
337 Warman	---	Redosier dogwood, Siberian peashrub.	Tamarack, black ash, black spruce.	Golden willow, white willow, eastern cottonwood.	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
346 Talmoon	---	Eastern redcedar, redosier dogwood, Siberian peashrub, lilac.	White spruce, Russian-olive, Siberian crabapple, blue spruce.	Golden willow, green ash, Norway spruce.	Eastern cottonwood, silver maple.
454B, 454C, 454D, 454F Mahtomedi	Lilac, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, Siberian peashrub.	Red pine, green ash, Russian-olive.	Eastern white pine, jack pine.	---
540 Seelyeville	Common ninebark	Redosier dogwood, Siberian peashrub.	Tamarack, black ash.	Golden willow, white willow.	Imperial Carolina poplar.
543 Markey	Common ninebark	Redosier dogwood, Siberian peashrub.	Tamarack, black ash.	Golden willow, white willow.	Imperial Carolina poplar.
544 Cathro	Common ninebark	Redosier dogwood, Siberian peashrub.	Tamarack, black ash.	Golden willow, white willow.	Imperial Carolina poplar.
545 Rondeau	Common ninebark	Redosier dogwood, Siberian peashrub.	Tamarack, black ash.	Golden willow, white willow.	Imperial Carolina poplar.
565 Eckvoll	---	Lilac, redosier dogwood, American cranberrybush, northern whitecedar.	Black spruce, white spruce, eastern redcedar, Siberian crabapple.	Eastern white pine, jack pine, red pine, green ash.	Silver maple, eastern cottonwood.
676B Kost	Lilac, Siberian peashrub.	Manchurian crabapple, Siberian crabapple, eastern redcedar.	Russian-olive, green ash, red pine.	Jack pine, eastern white pine.	---
677 Siren	---	Northern whitecedar, lilac, American cranberrybush, redosier dogwood.	White spruce, black spruce, eastern redcedar, Siberian crabapple.	Eastern white pine, red pine, jack pine, green ash.	Silver maple, eastern cottonwood.
678 Beltrami	---	Redosier dogwood, lilac, American cranberrybush, Siberian peashrub.	White spruce, black spruce, eastern redcedar, Siberian crabapple.	Eastern white pine, green ash, red pine, jack pine.	Silver maple, eastern cottonwood.
682B, 682C, 682D, 682E Milaca	---	Lilac, Amur maple, American cranberrybush, northern whitecedar, Siberian peashrub.	Manchurian crabapple, eastern redcedar, white spruce, Russian-olive.	Eastern white pine, jack pine, green ash, silver maple.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
717B Novak	Lilac	Eastern redcedar, common chokecherry, American plum, Amur maple, Siberian peashrub.	Jack pine, red pine, white spruce, blue spruce.	Green ash, silver maple.	Eastern cottonwood.
722 Blomford	---	Eastern redcedar, redosier dogwood, Siberian peashrub, lilac.	White spruce, Russian-olive, Siberian crabapple, blue spruce.	Golden willow, green ash, Norway spruce.	Eastern cottonwood, silver maple.
726 Kratka	---	Siberian peashrub, silver buffaloberry, redosier dogwood.	Green ash, Russian-olive, white spruce, tamarack.	White willow, golden willow, eastern cottonwood.	---
792. Fordum					
928B, 928C, 928D:					
Mahtomedi	Lilac, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, Siberian crabapple.	Red pine, green ash, Russian-olive.	Jack pine, eastern white pine.	---
Cushing	---	Redosier dogwood, Siberian peashrub, lilac, Amur maple.	Northern whitecedar, eastern redcedar, Manchurian crabapple, blue spruce, white spruce.	Green ash, red pine, eastern white pine, silver maple.	Eastern cottonwood.
1030:					
Udorthents.					
Pits.					
1068 Caryville	---	Northern whitecedar, lilac, American cranberrybush, redosier dogwood.	White spruce, black spruce, eastern redcedar, Siberian crabapple.	Eastern white pine, red pine, jack pine, green ash.	Silver maple, eastern cottonwood.
1069C:					
Fairport	Siberian peashrub, lilac.	American plum, common chokecherry, Manchurian crabapple.	Blue spruce, green ash, Russian-olive, jack pine.	Silver maple	---
Rock outcrop.					

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1070D:					
Plainbo	Lilac, Siberian peashrub.	Eastern redcedar, lilac, Manchurian crabapple, Siberian peashrub, lilac.	Red pine, Russian-olive, green ash.	Eastern white pine, jack pine.	---
Rock outcrop.					
1977 Mora	---	Amur maple, Siberian peashrub, lilac, American cranberrybush.	Manchurian crabapple, white spruce, eastern redcedar, Russian-olive.	Green ash, eastern white pine, jack pine, silver maple.	Eastern cottonwood.
1980 Ronneby	---	Siberian peashrub, American cranberrybush, lilac, redosier dogwood.	White spruce, black spruce, Siberian crabapple.	Red pine, jack pine, eastern white pine, green ash.	Silver maple, eastern cottonwood.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
40B Nebish	Slight	Slight	Moderate: slope.	Slight	Slight.
40C Nebish	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
40D Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
40F Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
75 Bluffton	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
119B Pomroy	Moderate: percs slowly, too sandy.	Moderate: too sandy, percs slowly.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
119C Pomroy	Moderate: slope, percs slowly.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
155B Chetek	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones, droughty.
155C Chetek	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, droughty, slope.
158B Zimmerman	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
158C Zimmerman	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
159B Anoka	Slight	Slight	Moderate: slope.	Slight	Slight.
159C Anoka	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
161 Isanti	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
162 Lino	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Moderate: droughty.
169B Braham	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
169C Braham	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
182 Halder	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
204B Cushing	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
204C Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
204D Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
204F Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
207B Nymore	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Severe: droughty.
207C Nymore	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Severe: droughty.
207D, 207E Nymore	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.	Severe: droughty, slope.
265 Soderville	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: too sandy, wetness.	Moderate: too sandy.	Moderate: droughty.
274 Newson	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
292 Alstad	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
325 Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
328B Sartell	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty.
328C Sartell	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Moderate: droughty, slope.
328D Sartell	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: slope.
337 Warman	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
346 Talmoon	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
454B Mahtomedi	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Moderate: small stones.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
454C Mahtomedi	Moderate: slope.	Moderate: slope.	Severe: slope, small stones.	Moderate: too sandy.	Moderate: small stones.
454D Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy.	Severe: slope.
454F Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: slope.
540 Seelyeville	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
543 Markey	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
544 Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
545 Rondeau	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
565 Eckvoll	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: small stones.	Moderate: too sandy.	Slight.
676B Kost	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: droughty.
677 Siren	Severe: wetness.	Moderate: wetness, small stones.	Severe: small stones, wetness.	Moderate: wetness.	Moderate: small stones, wetness.
678 Beltrami	Moderate: wetness.	Moderate: wetness.	Moderate: small stones, wetness.	Slight	Slight.
682B Milaca	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: large stones, slope, small stones.	Slight	Moderate: large stones, droughty.
682C Milaca	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: large stones, droughty, slope.
682D Milaca	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
682E Milaca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
717B Novak	Slight	Slight	Moderate: slope.	Severe: erodes easily.	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
722 Blomford	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
726 Kratka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
792 Fordum	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding, flooding.
928B:					
Mahtomedi	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Moderate: small stones.
Cushing	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
928C:					
Mahtomedi	Moderate: slope.	Moderate: slope.	Severe: slope, small stones.	Moderate: too sandy.	Moderate: small stones.
Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
928D:					
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy.	Severe: slope.
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1030:					
Udorthents.					
Pits.					
1068 Caryville	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: droughty, flooding.
1069C:					
Fairport	Slight	Slight	Severe: slope.	Severe: erodes easily.	Moderate: depth to rock.
Rock outcrop.					
1070D:					
Plainbo	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.					
1977 Mora	Moderate: wetness.	Moderate: wetness.	Moderate: large stones, slope, small stones.	Slight	Moderate: large stones.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1980 Ronneby	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: large stones, small stones, wetness.	Moderate: wetness.	Moderate: large stones, wetness.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
40B---------- Nebish	Good	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
40C---------- Nebish	Fair	Good	Good	Good	Fair	Very poor.	Very poor.	Good	Good	Very poor.
40D, 40F---------- Nebish	Poor	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
75---------- Bluffton	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
119B, 119C--------- Pomroy	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
155B, 155C--------- Chetek	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
158B, 158C--------- Zimmerman	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
159B, 159C--------- Anoka	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
161---------- Isanti	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
162---------- Lino	Poor	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Poor.
169B, 169C--------- Braham	Fair	Good	Good	Fair	Good	Very poor.	Very poor.	Fair	Good	Very poor.
182---------- Halder	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
204B---------- Cushing	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
204C---------- Cushing	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
204D---------- Cushing	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
204F---------- Cushing	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
207B, 207C--------- Nymore	Poor	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
207D, 207E--------- Nymore	Very poor.	Poor	Fair	Poor	Fair	Very poor.	Very poor.	Very poor.	Fair	Very poor.
265---------- Soderville	Poor	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Poor	Fair.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
274 Newson	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
292 Alstad	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
325 Prebish	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
328B, 328C, 328D Sartell	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
337 Warman	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
346 Talmoon	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
454B, 454C Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
454D, 454F Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
540 Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
543 Markey	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
544 Cathro	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
545 Rondeau	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
565 Eckvoll	Poor	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
676B Kost	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
677 Siren	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
678 Beltrami	Good	Good	Good	Good	Fair	Poor	Poor	Good	Good	Poor.
682B, 682C, 682D, 682E Milaca	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
717B Novak	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
722 Blomford	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
726 Kratka	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
792---------- Fordum	Very poor.	Very poor.	Poor	Fair	Fair	Good	Good	Very poor.	Fair	Good.
928B:										
Mahtomedi---------	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Cushing----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
928C:										
Mahtomedi---------	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
Cushing----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
928D:										
Mahtomedi---------	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Cushing----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
1030:										
Udorthents.										
Pits.										
1068---------- Caryville	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
1069C:										
Fairport----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Rock outcrop.										
1070D:										
Plainbo----------	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Rock outcrop.										
1977---------- Mora	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
1980---------- Ronneby	Poor	Fair	Good	Good	Good	Good	Good	Fair	Good	Good.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
40B Nebish	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
40C Nebish	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
40D, 40F Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
75 Bluffton	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
119B Pomroy	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
119C Pomroy	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
155B Chetek	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: large stones, droughty.
155C Chetek	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: large stones, droughty, slope.
158B Zimmerman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
158C Zimmerman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
159B Anoka	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Slight.
159C Anoka	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: frost action, slope.	Moderate: slope.
161 Isanti	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
162 Lino	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.
169B Braham	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
169C---------- Braham	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
182---------- Halder	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
204B---------- Cushing	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
204C---------- Cushing	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
204D, 204F-------- Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
207B---------- Nymore	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
207C---------- Nymore	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
207D, 207E-------- Nymore	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
265---------- Soderville	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.
274---------- Newson	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
292---------- Alstad	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
325---------- Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
328B---------- Sartell	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
328C---------- Sartell	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
328D---------- Sartell	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
337---------- Warman	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
346---------- Talmoon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
454B Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: small stones.
454C Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones.
454D, 454F Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
540 Seelyeville	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, excess humus.
543 Markey	Severe: cutbanks cave, excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
544 Cathro	Severe: excess humus, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
545 Rondeau	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, excess humus.
565 Eckvoll	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
676B Kost	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
677 Siren	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: small stones, wetness.
678 Beltrami	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Slight.
682B Milaca	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: large stones, droughty.
682C Milaca	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, droughty, slope.
682D, 682E Milaca	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
717B Novak	Severe: cutbanks cave.	Slight	Slight	Slight	Severe: frost action.	Slight.
722 Blomford	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
726 Kratka	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
792 Fordum	Severe: cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding.
928B:						
Mahtomedi	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: small stones.
Cushing	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
928C:						
Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones.
Cushing	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
928D:						
Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1030:						
Udorthents.						
Pits.						
1068 Caryville	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: droughty, flooding.
1069C:						
Fairport	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: low strength.	Moderate: depth to rock.
Rock outcrop.						
1070D:						
Plainbo	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope, depth to rock.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop.						
1977 Mora	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: large stones.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1980---------- Ronneby	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: large stones, wetness.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
40B Nebish	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
40C Nebish	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
40D, 40F Nebish	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
75 Bluffton	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
119B Pomroy	Severe: percs slowly.	Severe: seepage.	Slight	Severe: seepage.	Fair: small stones.
119C Pomroy	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
155B Chetek	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
155C Chetek	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
158B Zimmerman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
158C Zimmerman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
159B Anoka	Slight	Severe: seepage.	Severe: seepage, too sandy.	Slight	Fair: too sandy, thin layer.
159C Anoka	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Moderate: slope.	Fair: too sandy, slope, thin layer.
161 Isanti	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
162 Lino	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
169B Braham	Moderate: percs slowly.	Severe: seepage.	Moderate: too clayey.	Severe: seepage.	Fair: too clayey.
169C Braham	Moderate: percs slowly, slope.	Severe: seepage, slope.	Moderate: slope, too clayey.	Severe: seepage.	Fair: too clayey, slope.
182 Halder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
204B Cushing	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
204C Cushing	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
204D, 204F Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
207B Nymore	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
207C Nymore	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
207D, 207E Nymore	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
265 Soderville	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
274 Newson	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
292 Alstad	Severe: wetness, percs slowly.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.
325 Prebish	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
328B Sartell	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
328C Sartell	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
328D Sartell	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
337 Warman	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
346 Talmoon	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
454B Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454C Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454D, 454F Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
540 Seelyeville	Severe: ponding, subsides.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding, excess humus.
543 Markey	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
544 Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
545 Rondeau	Severe: ponding, subsides.	Severe: seepage, excess humus.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
565 Eckvoll	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
676B Kost	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
677 Siren	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
678 Beltrami	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
682B Milaca	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
682C Milaca	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
682D, 682E Milaca	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
717B Novak	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
722 Blomford	Severe: seepage, poor filter.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
726 Kratka	Severe: ponding, percs slowly, poor filter.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
792 Fordum	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: seepage, too sandy, ponding.
928B:					
Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Cushing	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
928C:					
Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Cushing	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
928D:					
Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1030:					
Udorthents.					
Pits.					
1068 Caryville	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage.	Poor: seepage, too sandy.
1069C:					
Fairport	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Rock outcrop.					
1070D:					
Plainbo	Severe: depth to rock, seepage, poor filter.	Severe: seepage, slope, depth to rock.	Severe: seepage, slope, depth to rock.	Severe: seepage, slope, depth to rock.	Poor: depth to rock, seepage, too sandy.
Rock outcrop.					
1977 Mora	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Moderate: wetness.	Moderate: wetness.	Fair: small stones, wetness.
1980 Ronneby	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: wetness.	Fair: small stones, wetness.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
40B Nebish	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
40C Nebish	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
40D Nebish	Fair: slope, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
40F Nebish	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
75 Bluffton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
119B, 119C Pomroy	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
155B, 155C Chetek	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
158B, 158C Zimmerman	Good	Probable	Improbable: too sandy.	Poor: too sandy.
159B Anoka	Good	Probable	Improbable: too sandy.	Fair: too sandy.
159C Anoka	Good	Probable	Improbable: too sandy.	Fair: too sandy, slope.
161 Isanti	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
162 Lino	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
169B, 169C Braham	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
182 Halder	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
204B, 204C Cushing	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
204D Cushing	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
204F Cushing	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
207B, 207C Nymore	Good	Probable	Improbable: too sandy.	Poor: too sandy.
207D, 207E Nymore	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
265 Soderville	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
274 Newson	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
292 Alstad	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
325 Prebish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
328B, 328C Sartell	Good	Probable	Improbable: too sandy.	Poor: too sandy.
328D Sartell	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
337 Warman	Poor: wetness.	Probable	Probable	Poor: small stones, area reclaim, wetness.
346 Talmoon	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
454B, 454C Mahtomedi	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
454D Mahtomedi	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
454F Mahtomedi	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
540 Seelyeville	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
543 Markey	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
544 Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
545 Rondeau	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
565 Eckvoll	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
676B Kost	Good	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
677 Siren	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
678 Beltrami	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
682B, 682C Milaca	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
682D Milaca	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
682E Milaca	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
717B Novak	Good	Probable	Probable	Poor: area reclaim.
722 Blomford	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, wetness.
726 Kratka	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
792 Fordum	Poor: wetness.	Probable	Improbable: too sandy.	Poor: small stones, wetness.
928B, 928C:				
Mahtomedi	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Cushing	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
928D:				
Mahtomedi	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Cushing	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
1030:				
Udorthents.				
Pits.				
1068 Caryville	Good	Probable	Improbable: too sandy.	Poor: too sandy.
1069C:				
Fairport	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Rock outcrop.				
1070D:				
Plainbo	Poor: depth to rock, slope.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy, slope.
Rock outcrop.				
1977 Mora	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
1980 Ronneby	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
40B Nebish	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Favorable	Favorable.
40C, 40D, 40F Nebish	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope	Slope.
75 Bluffton	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding	Ponding	Wetness.
119B Pomroy	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Rooting depth, soil blowing.	Droughty, rooting depth.
119C Pomroy	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, rooting depth, soil blowing.	Slope, droughty, rooting depth.
155B Chetek	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
155C Chetek	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty.	Slope, too sandy.	Slope, droughty.
158B Zimmerman	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
158C Zimmerman	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
159B Anoka	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Fast intake, soil blowing, slope.	Soil blowing	Favorable.
159C Anoka	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Fast intake, soil blowing, slope.	Slope, soil blowing.	Slope.
161 Isanti	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
162 Lino	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
169B Braham	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Soil blowing	Droughty.
169C Braham	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, soil blowing.	Slope, droughty.
182 Halder	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
204B Cushing	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope	Favorable	Favorable.
204C, 204D, 204F Cushing	Severe: slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope	Slope	Slope.
207B Nymore	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
207C, 207D, 207E Nymore	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
265 Soderville	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty, rooting depth.
274 Newson	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Ponding, too sandy, soil blowing.	Wetness, droughty.
292 Alstad	Moderate: seepage.	Severe: thin layer.	Severe: no water.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
325 Prebish	Slight	Severe: piping, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding	Ponding	Wetness.
328B Sartell	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
328C, 328D Sartell	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
337 Warman	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, frost action, cutbanks cave.	Ponding, rooting depth.	Ponding, too sandy.	Wetness, rooting depth.
346 Talmoon	Slight	Severe: piping, wetness.	Severe: slow refill.	Frost action	Wetness	Erodes easily, wetness.	Wetness, erodes easily.
454B Mahtomedi	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
454C, 454D, 454F Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty, rooting depth.
540 Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides.	Ponding	Ponding	Wetness.
543 Markey	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
544 Cathro	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
545 Rondeau	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides.	Ponding, soil blowing, percs slowly.	Ponding, soil blowing.	Wetness.
565 Eckvoll	Severe: seepage.	Moderate: piping, wetness.	Severe: cutbanks cave.	Frost action	Wetness, fast intake, soil blowing.	Wetness, soil blowing, erodes easily.	Erodes easily.
676B Kost	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
677 Siren	Slight	Severe: hard to pack.	Severe: no water.	Frost action	Wetness	Wetness	Wetness.
678 Beltrami	Moderate: seepage.	Severe: piping.	Moderate: deep to water, slow refill.	Frost action	Wetness	Wetness	Favorable.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
682B Milaca	Moderate: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, percs slowly.	Percs slowly	Droughty, rooting depth.
682C, 682D, 682E Milaca	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, droughty, percs slowly.	Slope, percs slowly.	Slope, droughty, rooting depth.
717B Novak	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, erodes easily.	Erodes easily, too sandy.	Erodes easily.
722 Blomford	Severe: seepage.	Severe: piping, wetness.	Severe: cutbanks cave.	Favorable	Wetness, droughty.	Erodes easily, wetness, soil blowing.	Wetness, erodes easily, droughty.
726 Kratka	Severe: seepage.	Severe: piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding	Wetness, droughty, fast intake.	Ponding, soil blowing.	Wetness, droughty, rooting depth.
792 Fordum	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, flooding, frost action.	Ponding, flooding.	Ponding, too sandy.	Wetness.
928B:							
Mahtomedi	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
Cushing	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope	Favorable	Favorable.
928C, 928D:							
Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty, rooting depth.
Cushing	Severe: slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope	Slope	Slope.
1030:							
Udorthents.							
Pits.							
1068 Caryville	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
Rock outcrop.							

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
1069C:							
Fairport	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope, depth to rock.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
1070D:							
Plainbo	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, depth to rock, too sandy.	Slope, droughty, depth to rock.
Rock outcrop.							
1977 Mora	Moderate: seepage.	Severe: piping.	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Wetness, percs slowly.	Rooting depth, percs slowly.
1980 Ronneby	Moderate: seepage.	Severe: piping.	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Wetness	Rooting depth, percs slowly.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
40B---------- Nebish	0-10	Loam----------	ML	A-4	0-3	95-100	85-98	85-95	50-70	20-40	1-10
	10-40	Clay loam, loam	CL, ML	A-6, A-7	0-3	95-100	85-98	70-95	55-80	30-50	10-20
	40-60	Loam, clay loam, sandy clay loam.	CL, ML, CL-ML	A-4, A-6	0-3	95-100	85-98	70-95	50-80	20-40	5-20
40C---------- Nebish	0-8	Loam----------	ML	A-4	0-3	95-100	85-98	85-95	50-70	20-40	1-10
	8-33	Clay loam, loam	CL, ML	A-6, A-7	0-3	95-100	85-98	70-95	55-80	30-50	10-20
	33-60	Loam, clay loam, sandy clay loam.	CL, ML, CL-ML	A-4, A-6	0-3	95-100	85-98	70-95	50-80	20-40	5-20
40D---------- Nebish	0-7	Loam----------	ML	A-4	0-3	95-100	85-98	85-95	50-70	20-40	1-10
	7-42	Clay loam, loam	CL, ML	A-6, A-7	0-3	95-100	85-98	70-95	55-80	30-50	10-20
	42-60	Loam, clay loam, sandy clay loam.	CL, ML, CL-ML	A-4, A-6	0-3	95-100	85-98	70-95	50-80	20-40	5-20
40F---------- Nebish	0-6	Loam----------	ML	A-4	0-3	95-100	85-98	85-95	50-70	20-40	1-10
	6-36	Clay loam, loam	CL, ML	A-6, A-7	0-3	95-100	85-98	70-95	55-80	30-50	10-20
	36-60	Loam, clay loam, sandy clay loam.	CL, ML, CL-ML	A-4, A-6	0-3	95-100	85-98	70-95	50-80	20-40	5-20
75---------- Bluffton	0-19	Loam----------	CL	A-6, A-7	0	98-100	85-98	85-95	50-80	30-45	10-20
	19-40	Fine sandy loam, loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0-3	95-100	85-98	70-90	40-60	20-35	3-18
	40-60	Loam, sandy clay loam, fine sandy loam.	CL, ML, SC, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-65	20-40	3-20
119B---------- Pomroy	0-9	Loamy fine sand	SM	A-2, A-1-b	0	100	95-100	45-80	15-35	---	NP
	9-20	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2, A-1-b	0	100	95-100	45-80	10-35	---	NP
	20-40	Fine sandy loam, sandy loam, gravelly sandy loam.	SM	A-4, A-2	0-10	85-95	70-95	50-70	25-45	<22	NP-4
	40-60	Sandy loam, fine sandy loam, gravelly sandy loam.	SM	A-4, A-2	0-5	85-95	70-95	50-70	25-40	<22	NP-4
119C---------- Pomroy	0-5	Loamy fine sand	SM	A-2, A-1-b	0	100	95-100	45-80	15-35	---	NP
	5-25	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2, A-1-b	0	100	95-100	45-80	10-35	---	NP
	25-45	Fine sandy loam, sandy loam, gravelly sandy loam.	SM	A-4, A-2	0-10	85-95	70-95	50-70	25-45	<22	NP-4
	45-60	Sandy loam, fine sandy loam, gravelly sandy loam.	SM	A-4, A-2	0-5	85-95	70-95	50-70	25-40	<22	NP-4
155B---------- Chetek	0-9	Sandy loam--------	SM, SC-SM	A-4, A-2-4	0-15	85-100	85-100	45-70	25-40	<23	NP-6
	9-24	Sandy loam, loam	ML, CL, SM, SC	A-2, A-4, A-6	0-15	85-100	85-100	45-95	25-75	<31	NP-13
	24-60	Stratified sand to gravelly coarse sand.	SP, SP-SM	A-1-b	0-15	55-95	50-75	15-50	1-10	---	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
155C---------- Chetek	0-4	Loam----------	ML, CL, SM, SC	A-4, A-6	0-15	85-100	85-100	65-95	45-75	<31	NP-13
	4-23	Sandy loam, loam	ML, CL, SM, SC	A-2, A-4, A-6	0-15	85-100	85-100	45-95	25-75	<31	NP-13
	23-60	Stratified sand to gravelly coarse sand.	SP, SP-SM	A-1-b	0-15	55-95	45-75	15-50	1-10	---	NP
158B, 158C------- Zimmerman	0-8	Loamy fine sand	SM	A-2	0	95-100	92-100	90-100	15-30	<20	NP
	8-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	95-100	92-100	90-100	5-20	<20	NP
159B---------- Anoka	0-9	Loamy very fine sand.	SM	A-2	0	100	100	95-100	20-35	<20	NP
	9-51	Very fine sand, loamy very fine sand, very fine sandy loam.	SM	A-2, A-4	0	100	100	90-100	30-50	---	NP
	51-60	Very fine sand, fine sand.	SM, SP-SM	A-2	0	100	100	90-100	12-35	---	NP
159C---------- Anoka	0-6	Loamy fine sand	SM	A-2	0	100	100	95-100	20-35	<20	NP
	6-56	Very fine sand, loamy very fine sand, very fine sandy loam.	SM	A-2, A-4	0	100	100	90-100	30-50	---	NP
	56-60	Very fine sand, fine sand.	SM, SP-SM	A-2	0	100	100	90-100	12-35	---	NP
161---------- Isanti	0-12	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	100	75-100	5-35	<20	NP
	12-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	100	85-100	5-35	<20	NP
162---------- Lino	0-8	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
	8-42	Fine sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	95-100	12-25	<20	NP
	42-60	Fine sand, sand	SM, SP-SM, SP	A-2, A-3	0	100	100	90-100	2-20	<20	NP
169B---------- Braham	0-8	Loamy fine sand	SM	A-2	0	100	100	55-70	20-35	<20	NP
	8-20	Loamy fine sand, loamy sand, fine sand.	SP-SM, SM	A-2	0	100	100	65-90	10-20	<20	NP
	20-41	Sandy clay loam, fine sandy loam, clay loam.	CL, ML, SC	A-4, A-6, A-7	0-3	95-100	85-95	80-95	45-70	28-43	10-21
	41-60	Sandy clay loam, loam, clay loam.	CL, ML, SC	A-4, A-6, A-7	0-3	95-100	85-95	80-95	45-70	28-43	10-21
169C---------- Braham	0-8	Loamy fine sand	SM	A-2	0	100	100	55-70	20-35	<20	NP
	8-20	Loamy fine sand, loamy sand, fine sand.	SP-SM, SM	A-2	0	100	100	65-90	10-20	<20	NP
	20-55	Sandy clay loam, fine sandy loam, clay loam.	CL, ML, SC	A-4, A-6, A-7	0-3	95-100	85-95	80-95	45-70	28-43	10-21
	55-60	Sandy clay loam, loam, clay loam.	CL, ML, SC	A-4, A-6, A-7	0-3	95-100	85-95	80-95	45-70	28-43	10-21

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
182---------- Halder	0-12	Sandy loam-------	SM, SC-SM	A-4, A-2-4, A-1-b	0-3	90-100	85-100	45-70	20-40	<25	NP-7
	12-32	Sandy clay loam, silt loam, loam.	CL, SC, SM, ML	A-4, A-2-4	0-3	90-100	85-100	60-100	25-95	<30	NP-11
	32-40	Sandy loam, gravelly sandy loam, loamy sand.	SM, SC-SM, SP-SM, GM	A-2, A-4, A-1	0-8	70-95	50-95	40-70	12-40	<25	NP-7
	40-60	Gravelly sand, very gravelly coarse sand, sand.	SP, SM, GP, GM	A-1, A-2, A-3	0-10	60-95	50-95	15-70	1-25	---	NP
204B---------- Cushing	0-5	Loam----------	CL, ML, SC, SM	A-4	0-7	90-100	85-98	65-100	45-100	<28	3-9
	5-12	Loam, silt loam, sandy loam.	SM, SC-SM, ML, CL-ML	A-2, A-4, A-1	0-7	90-100	85-98	35-100	12-90	<23	NP-6
	12-40	Loam, sandy clay loam, sandy loam.	SC	A-2, A-4, A-6, A-7	0-7	90-100	85-98	45-95	20-50	25-45	9-27
	40-60	Loam, sandy clay loam, sandy loam.	SC, SM, SC-SM	A-2, A-4, A-6, A-1	0-7	90-100	85-98	45-95	20-50	<34	2-20
204C---------- Cushing	0-8	Loam----------	CL, ML, SC, SM	A-4	0-7	90-100	85-98	65-100	45-100	<28	3-9
	8-14	Loam, silt loam, sandy loam.	SM, SC-SM, ML, CL-ML	A-2, A-4, A-1	0-7	90-100	85-98	35-100	12-90	<23	NP-6
	14-53	Loam, sandy clay loam, sandy loam.	SC	A-2, A-4, A-6, A-7	0-7	90-100	85-98	45-95	20-50	25-45	9-27
	53-60	Loam, sandy clay loam, sandy loam.	SC, SM, SC-SM	A-2, A-4, A-6, A-1	0-7	90-100	85-98	45-95	20-50	<34	2-20
204D---------- Cushing	0-7	Loam----------	CL, ML, SC, SM	A-4	0-7	90-100	85-98	65-100	45-100	<28	3-9
	7-40	Loam, sandy clay loam, sandy loam.	SC	A-2, A-4, A-6, A-7	0-7	90-100	85-98	45-95	20-50	25-45	9-27
	40-60	Loam, sandy clay loam, sandy loam.	SC, SM, SC-SM	A-2, A-4, A-6, A-1	0-7	90-100	85-98	45-95	20-50	<34	2-20
204F---------- Cushing	0-3	Loam----------	CL, ML, SC, SM	A-4	0-7	90-100	85-98	65-100	45-100	<28	3-9
	3-6	Loam, silt loam, sandy loam.	SM, SC-SM, ML, CL-ML	A-2, A-4, A-1	0-7	90-100	85-98	35-100	12-90	<23	NP-6
	6-32	Loam, sandy clay loam, sandy loam.	SC	A-2, A-4, A-6, A-7	0-7	90-100	85-98	45-95	20-50	25-45	9-27
	32-60	Loam, sandy clay loam, sandy loam.	SC, SM, SC-SM	A-2, A-4, A-6, A-1	0-7	90-100	85-98	45-95	20-50	<34	2-20
207B---------- Nymore	0-7	Loamy sand-------	SM, SP-SM	A-2, A-3	0	95-100	85-100	50-75	5-30	<20	NP
	7-27	Sand, coarse sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	95-100	85-100	45-75	2-15	<20	NP
	27-60	Sand, coarse sand	SP, SP-SM, SM	A-1, A-3, A-2	0	95-100	85-100	45-75	2-15	<20	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
207C---------- Nymore	0-4	Loamy sand-------	SM, SP-SM	A-2, A-3	0	95-100	85-100	50-75	5-30	<20	NP
	4-15	Sand, coarse sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	95-100	85-100	45-75	2-15	<20	NP
	15-60	Sand, coarse sand	SP, SP-SM, SM	A-1, A-3, A-2	0	95-100	85-100	45-75	2-15	<20	NP
207D---------- Nymore	0-5	Loamy sand-------	SM, SP-SM	A-2, A-3	0	95-100	85-100	50-75	5-30	<20	NP
	5-21	Sand, coarse sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	95-100	85-100	45-75	2-15	<20	NP
	21-60	Sand, coarse sand	SP, SP-SM, SM	A-1, A-3, A-2	0	95-100	85-100	45-75	2-15	<20	NP
207E---------- Nymore	0-4	Loamy sand-------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-75	5-30	<20	NP
	4-18	Sand, coarse sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	95-100	85-100	45-75	2-15	<20	NP
	18-60	Sand, coarse sand	SP, SP-SM, SM	A-1, A-3, A-2	0	95-100	85-100	45-75	2-15	<20	NP
265---------- Soderville	0-9	Loamy fine sand	SM, SP-SM	A-2	0	100	100	95-100	10-35	---	NP
	9-32	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	8-35	---	NP
	32-45	Fine sand, loamy fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	100	100	95-100	6-35	---	NP
	45-60	Fine sand, sand, loamy sand.	SP, SP-SM, SM	A-2, A-3	0	100	100	85-100	2-20	---	NP
274---------- Newson	0-8	Mucky loamy sand	SM	A-2, A-1-b	0	80-100	75-100	40-85	12-35	---	NP
	8-32	Loamy sand, sand	SM, SP-SM, SP	A-2, A-3, A-1-b	0	80-100	75-100	45-75	3-30	---	NP
	32-60	Sand, loamy sand	SM, SP-SM, SP	A-2, A-3, A-1-b	0	80-100	75-100	45-75	3-30	---	NP
292---------- Alstad	0-9	Loam----------	CL, CL-ML, ML	A-4	0	90-100	85-98	80-100	55-100	<28	3-9
	9-13	Silt loam, loam, sandy loam.	ML, CL, SM, SC	A-2, A-4	0	90-100	85-98	55-100	25-100	<26	2-8
	13-25	Loam, silt loam, silty clay loam.	CL, SC	A-4, A-6, A-7	0	90-100	85-98	65-100	45-95	25-45	9-27
	25-39	Sandy clay loam, clay loam, loam.	CL, SC	A-6, A-4, A-2, A-7	0	90-100	85-98	60-100	25-80	20-45	9-28
	39-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-6, A-4, A-2, A-1	0-3	90-100	85-98	45-95	20-75	<35	2-20
325---------- Prebish	0-10	Sandy loam-------	SM	A-4	0-2	90-100	90-100	55-80	35-50	<20	NP-4
	10-42	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	90-100	75-90	45-80	25-50	<20	NP-4
	42-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	75-90	55-70	20-35	<20	NP-4
328B---------- Sartell	0-8	Fine sand--------	SM, SP-SM	A-2, A-3	0	100	100	90-100	7-20	---	NP
	8-25	Fine sand--------	SP-SM, SM	A-2, A-3	0	100	100	90-100	7-20	---	NP
	25-60	Fine sand--------	SP, SP-SM	A-3, A-2	0	100	100	85-95	1-12	---	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
328C---------- Sartell	0-5	Fine sand--------	SM, SP-SM	A-2, A-3	0	100	100	90-100	7-20	---	NP
	5-29	Fine sand--------	SP-SM, SM	A-2, A-3	0	100	100	90-100	7-20	---	NP
	29-60	Fine sand--------	SP, SP-SM	A-3, A-2	0	100	100	85-95	1-12	---	NP
328D---------- Sartell	0-4	Fine sand--------	SM, SP-SM	A-2, A-3	0	100	100	90-100	7-20	---	NP
	4-26	Fine sand--------	SP-SM, SM	A-2, A-3	0	100	100	90-100	7-20	---	NP
	26-60	Fine sand--------	SP, SP-SM	A-3, A-2	0	100	100	85-95	1-12	---	NP
337---------- Warman	0-10	Loam----------	OL, ML, CL-ML	A-4	0-5	95-100	85-100	65-90	50-85	<30	NP-5
	10-34	Loam, silt loam, fine sandy loam.	ML, CL-ML	A-4	0-5	95-100	85-100	65-90	50-85	25-35	NP-5
	34-60	Gravelly sand, gravelly coarse sand, sand.	GW, GP, SP, SW	A-1	0-15	60-95	55-95	5-50	2-25	---	NP
346---------- Talmoon	0-9	Loam----------	ML, CL, CL-ML	A-4	0	95-100	85-98	70-100	60-90	20-32	3-10
	9-12	Very fine sandy loam, sandy loam, loam.	CL, SC, CL-ML, SC-SM	A-4, A-6	0	95-100	85-98	60-95	35-75	23-35	6-15
	12-24	Clay loam, silty clay loam, loam.	CL, ML	A-6, A-7, A-4	0	95-100	85-98	70-100	50-95	30-50	9-20
	24-60	Loam, sandy clay loam, clay loam.	CL, CL-ML, SC, SC-SM	A-6, A-4, A-7	0	95-100	85-98	75-100	45-80	25-45	6-18
454B---------- Mahtomedi	0-8	Loamy sand-------	SM, SC-SM	A-2, A-1	0-2	95-100	75-95	40-85	15-30	<20	NP-4
	8-22	Sand, coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2, A-3	0-2	80-100	75-95	30-75	5-15	<20	NP
	22-40	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-10	70-95	50-85	30-75	5-15	<20	NP
	40-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-10	55-95	50-85	30-70	2-15	<20	NP
454C---------- Mahtomedi	0-8	Loamy sand-------	SM, SC-SM	A-2, A-1	0-2	95-100	75-95	40-85	15-30	<20	NP-4
	8-29	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-10	80-100	50-85	30-75	5-15	<20	NP
	29-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-10	55-95	50-85	30-70	2-15	<20	NP
454D---------- Mahtomedi	0-4	Loamy sand-------	SM, SC-SM	A-2, A-1	0-2	95-100	75-95	40-85	15-30	<20	NP-4
	4-12	Sand, coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2, A-3	0-2	80-100	75-90	30-75	5-15	<20	NP
	12-34	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-10	70-95	50-85	30-75	5-15	<20	NP
	34-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-10	55-95	50-85	30-70	2-15	<20	NP
454F---------- Mahtomedi	0-3	Loamy sand-------	SM, SC-SM	A-2, A-1	0-2	95-100	75-95	40-85	15-30	<20	NP-4
	3-9	Sand, coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2, A-3	0-2	80-100	75-90	30-75	5-15	<20	NP
	9-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-10	55-95	50-85	30-70	2-15	<20	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
540---------- Seelyeville	0-32	Muck----------	PT	A-8	0	---	---	---	---	---	---
	32-60	Muck, mucky peat	PT	A-8	0	---	---	---	---	---	---
543---------- Markey	0-30	Muck----------	PT	A-8	---	---	---	---	---	---	---
	30-60	Sand, loamy sand, fine sand.	SP, SM, SP-SM	A-2, A-3	0	98-100	75-100	60-75	0-20	---	NP
544---------- Cathro	0-38	Muck----------	PT	A-8	0	---	---	---	---	---	---
	38-60	Sandy loam, loam, silt loam.	SM, ML, SC, CL	A-4	0-5	85-100	75-100	60-100	35-90	<25	3-10
545---------- Rondeau	0-39	Muck----------	PT	A-8	0	---	---	---	---	---	---
	39-60	Marl----------	OH, MH	A-8, A-5, A-7	0	100	100	80-90	60-80	50-90	NP-20
565---------- Eckvoll	0-8	Loamy sand-------	SM, SC-SM	A-4, A-2	0-2	90-100	85-100	45-80	25-40	<20	NP-7
	8-24	Fine sand, sand, loamy sand.	SM, SP-SM	A-1, A-2, A-3	0-2	90-100	85-100	45-75	5-30	<20	NP-4
	24-45	Clay loam, sandy clay loam, loam.	SC, CL	A-4, A-6, A-7	0-5	90-100	85-100	65-95	45-75	25-50	7-25
	45-60	Loam, clay loam, sandy clay loam.	CL	A-4, A-6, A-7	0-5	90-98	85-98	70-95	55-80	25-45	7-20
676B---------- Kost	0-17	Loamy fine sand	SM	A-2, A-4	0	90-100	90-100	85-100	15-50	---	NP
	17-29	Fine sand, sand	SM, SP-SM	A-2, A-3	0	90-100	90-100	75-100	5-35	---	NP
	29-60	Fine sand, sand	SM, SP-SM, SP	A-2, A-3	0	90-100	90-100	75-100	2-30	---	NP
677---------- Siren	0-2	Silt loam--------	CL, SC	A-4, A-6	0-5	95-100	90-100	60-100	40-90	25-35	7-14
	2-6	Loam, silt loam, fine sandy loam.	SM, ML	A-2, A-1, A-4	0-5	95-100	90-100	40-100	20-90	<21	NP-4
	6-34	Clay, silty clay	CH, CL	A-7	0	100	100	95-100	75-95	48-70	25-45
	34-60	Clay, silty clay	CH, CL	A-7	0	100	100	95-100	75-95	48-70	25-45
678---------- Beltrami	0-8	Loam----------	ML, CL, CL-ML	A-4	0-3	95-100	85-98	75-95	50-65	20-30	3-10
	8-11	Fine sandy loam, loam, sandy loam.	SM, SC-SM, ML, CL-ML	A-4	0-3	95-100	85-98	60-90	35-65	<25	NP-7
	11-32	Loam, sandy clay loam, clay loam.	CL	A-6, A-7	0-3	95-100	85-98	75-95	50-85	20-45	10-30
	32-60	Loam, clay loam	CL-ML, CL	A-4, A-6	1-3	95-100	85-98	70-95	50-80	20-40	5-20
682B---------- Milaca	0-6	Sandy loam-------	SM	A-4	2-15	90-100	75-98	60-85	35-50	<22	NP-4
	6-16	Fine sandy loam, very fine sandy loam.	SM	A-4	0-2	90-100	75-98	60-80	35-50	<22	NP-4
	16-24	Sandy loam, fine sandy loam, loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	24-35	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	35-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	25-40	<22	NP-4

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
682C---------- Milaca	0-6	Sandy loam-------	SM	A-4	2-15	90-100	75-98	60-85	35-50	<22	NP-4
	6-15	Fine sandy loam, very fine sandy loam.	SM	A-4	0-2	90-100	75-98	60-80	35-50	<22	NP-4
	15-23	Sandy loam, fine sandy loam, loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	23-35	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	35-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	25-40	<22	NP-4
682D---------- Milaca	0-6	Sandy loam-------	SM	A-4	2-15	90-100	75-98	60-85	35-50	<22	NP-4
	6-14	Fine sandy loam, very fine sandy loam.	SM	A-4	0-2	90-100	75-98	60-80	35-50	<22	NP-4
	14-25	Sandy loam, fine sandy loam, loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	25-40	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	40-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	25-40	<22	NP-4
682E---------- Milaca	0-4	Sandy loam-------	SM	A-4	2-15	90-100	75-98	60-85	35-50	<22	NP-4
	4-16	Fine sandy loam, very fine sandy loam.	SM	A-4	0-2	90-100	75-98	60-80	35-50	<22	NP-4
	16-22	Sandy loam, fine sandy loam, loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	22-40	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	30-40	<22	NP-4
	40-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-98	50-70	25-40	<22	NP-4
717B---------- Novak	0-8	Silt loam--------	ML, CL-ML, CL	A-4	0	100	100	95-100	85-95	21-34	4-14
	8-17	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	95-100	85-95	21-34	4-14
	17-34	Silt loam, silty clay loam.	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-95	28-39	9-18
	34-38	Loam, sandy loam, gravelly sandy loam.	CL, CL-ML, SM	A-4, A-6	0-3	95-100	50-90	30-90	15-70	10-28	NP-9
	38-60	Sand, coarse sand, coarse gravelly sand.	SP, SP-SM	A-1, A-3	0-3	60-95	50-90	10-65	1-12	---	NP
722---------- Blomford	0-8	Loamy sand-------	SM	A-2	0	100	98-100	55-70	20-35	10-20	NP
	8-24	Loamy fine sand, loamy sand, fine sand.	SP-SM, SM	A-2	0	100	98-100	65-90	10-20	10-20	NP
	24-37	Silt loam, silty clay loam.	CL, ML	A-4, A-6, A-7	0	100	98-100	95-100	85-95	30-45	6-20
	37-60	Silt loam, silty clay loam.	ML, CL-ML, CL	A-4, A-6	0	100	98-100	95-100	85-95	20-40	4-18
726---------- Kratka	0-10	Loamy fine sand	SM	A-2	0	95-100	85-100	50-80	15-35	<20	NP-4
	10-30	Loamy sand, loamy fine sand, sand.	SP-SM	A-3, A-2	0	95-100	85-100	50-80	5-10	<20	NP-4
	30-60	Loam, clay loam, sandy loam.	SC-SM, SC, CL-ML, CL	A-4, A-6	0-3	95-100	85-95	70-90	40-60	21-43	4-21

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
792---------- Fordum	0-26	Sandy loam-------	SM, SC-SM, ML, CL-ML	A-4, A-2, A-1	0-15	80-100	75-100	45-95	20-65	<25	3-7
	26-40	Silt loam, fine sandy loam, loam.	SM, SC, ML, CL	A-2, A-4, A-1	0-15	80-100	75-100	45-100	20-90	<30	3-10
	40-60	Sand, fine sand, loamy fine sand.	SP, SM	A-3, A-2, A-1	0-15	80-100	75-100	35-80	2-35	---	NP
928B:											
Mahtomedi-------	0-8	Loamy sand-------	SM, SC-SM	A-2, A-1	0-2	95-100	75-95	40-85	15-30	<20	NP-4
	8-40	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-10	80-100	50-85	30-75	5-15	<20	NP
	40-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-10	55-95	50-85	30-70	2-15	<20	NP
Cushing---------	0-5	Loam----------	CL, ML, SC, SM	A-4	0-7	90-100	85-98	65-100	45-100	<28	3-9
	5-12	Loam, silt loam, sandy loam.	SM, SC-SM, ML, CL-ML	A-2, A-4, A-1	0-7	90-100	85-98	35-100	12-90	<23	NP-6
	12-40	Loam, sandy clay loam, sandy loam.	SC	A-2, A-4, A-6, A-7	0-7	90-100	85-98	45-95	20-50	25-45	9-27
	40-60	Loam, sandy clay loam, sandy loam.	SC, SM, SC-SM	A-2, A-4, A-6, A-1	0-7	90-100	85-98	45-95	20-50	<34	2-20
928C:											
Mahtomedi-------	0-8	Loamy sand-------	SM, SC-SM	A-2, A-1	0-2	90-100	75-95	40-85	15-30	<20	NP-4
	8-29	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-10	80-100	50-85	30-75	5-15	<20	NP
	29-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-10	55-95	50-85	30-70	2-15	<20	NP
Cushing---------	0-8	Loam----------	CL, ML, SC, SM	A-4	0-7	90-100	85-98	65-100	45-100	<28	3-9
	8-14	Loam, silt loam, sandy loam.	SM, SC-SM, ML, CL-ML	A-2, A-4, A-1	0-7	90-100	85-98	35-100	12-90	<23	NP-6
	14-53	Loam, sandy clay loam, sandy loam.	SC	A-2, A-4, A-6, A-7	0-7	90-100	85-98	45-95	20-50	25-45	9-27
	53-60	Loam, sandy clay loam, sandy loam.	SC, SM, SC-SM	A-2, A-4, A-6, A-1	0-7	90-100	85-98	45-95	20-50	<34	2-20
928D:											
Mahtomedi-------	0-4	Loamy sand-------	SM, SC-SM	A-2, A-1	0-2	95-100	75-95	40-85	15-30	<20	NP-4
	4-12	Sand, coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2, A-3	0-2	55-95	50-85	30-75	5-15	<20	NP
	12-34	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-10	55-95	50-85	30-75	5-15	<20	NP
	34-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-10	55-95	50-85	30-70	2-15	<20	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments >3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
928D:											
Cushing---------	0-7	Loam----------	CL, ML, SC, SM	A-4	0-7	90-100	85-98	65-100	45-100	<28	3-9
	7-40	Loam, sandy clay loam, sandy loam.	SC	A-2, A-4, A-6, A-7	0-7	90-100	85-98	45-95	20-50	25-45	9-27
	40-60	Loam, sandy clay loam, sandy loam.	SC, SM, SC-SM	A-2, A-4, A-6, A-1	0-7	90-100	85-98	45-95	20-50	<34	2-20
1030:											
Udorthents.											
Pits.											
1068---------- Caryville	0-10	Sandy loam-------	SM, SC-SM, ML, CL-ML	A-2, A-4	0	90-100	90-100	55-85	25-55	<25	2-7
	10-60	Stratified sand to loam.	SM, SP-SM, SP	A-2, A-3, A-4	0	90-100	90-100	65-90	1-50	---	NP
1069C:											
Fairport--------	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	85-100	75-98	70-95	55-90	20-30	6-11
	8-24	Loam, sandy loam	SM, SC, ML, CL	A-2, A-4, A-6	0-5	85-100	75-98	60-95	20-70	<30	2-15
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
1070D:											
Plainbo---------	0-5	Loamy sand-------	SM	A-2	0	90-100	85-100	50-85	15-35	---	NP
	5-23	Sand, loamy sand, fine sand.	SP-SM, SM	A-2, A-3	0	90-100	85-100	50-75	5-35	---	NP
	23	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
1977---------- Mora	0-4	Loam----------	SM	A-4	2-15	90-100	75-98	60-85	35-50	<20	NP-4
	4-12	Fine sandy loam, sandy loam, loam.	SM, ML	A-4	0-2	90-100	75-98	70-90	40-60	<20	NP-4
	12-30	Fine sandy loam, sandy loam.	SM, ML	A-4	0-2	90-100	75-98	70-90	40-60	<20	NP-4
	30-50	Fine sandy loam, sandy loam.	SM	A-4, A-2	0-4	85-100	75-98	60-80	30-40	<20	NP-4
	50-60	Fine sandy loam, sandy loam.	SM	A-4, A-2	0-4	85-100	75-98	60-80	30-40	<20	NP-4
1980---------- Ronneby	0-7	Loam----------	SM	A-4	3-15	90-100	75-98	60-85	35-45	<20	NP-4
	7-19	Fine sandy loam, sandy loam, loam.	SM, ML	A-4	0-5	90-100	75-98	60-85	35-65	<25	NP-4
	19-35	Fine sandy loam, sandy loam, loam.	SM, ML, CL-ML, SC-SM	A-4	0-5	90-100	75-98	60-85	35-60	20-30	2-7
	35-44	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-100	75-98	60-80	25-50	<20	NP-4
	44-60	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-100	75-98	60-80	25-50	<20	NP-4

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
40B---------- Nebish	0-10	5-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.32	5	5	1-2
	10-40	22-35	1.50-1.65	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32			
	40-60	18-30	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.32			
40C---------- Nebish	0-8	5-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.32	5	5	1-2
	8-33	22-35	1.50-1.65	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32			
	33-60	18-30	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.32			
40D---------- Nebish	0-7	5-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.32	5	5	1-2
	7-42	22-35	1.50-1.65	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32			
	42-60	18-30	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.32			
40F---------- Nebish	0-6	5-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.32	5	5	1-2
	6-36	22-35	1.50-1.65	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32			
	36-60	18-30	1.50-1.70	0.6-2.0	0.11-0.19	7.4-8.4	Low----------	0.32			
75---------- Bluffton	0-19	14-25	1.25-1.40	0.6-2.0	0.20-0.24	5.6-6.5	Low----------	0.28	5	5	3-7
	19-40	18-30	1.45-1.55	0.6-6.0	0.15-0.17	5.6-7.3	Low----------	0.28			
	40-60	18-30	1.50-1.65	0.2-0.6	0.15-0.19	7.4-8.4	Low----------	0.28			
119B---------- Pomroy	0-9	5-12	1.40-1.50	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	4	2	.5-1
	9-20	2-10	1.50-1.70	6.0-20	0.06-0.09	5.1-6.5	Low----------	0.15			
	20-40	6-18	1.65-1.90	<0.2	0.-0.08	5.1-6.5	Low----------	0.15			
	40-60	5-18	1.80-2.00	<0.06	0.-0.04	5.6-7.3	Low----------	0.24			
119C---------- Pomroy	0-5	5-12	1.40-1.50	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	4	2	.5-1
	5-25	2-10	1.50-1.70	6.0-20	0.06-0.09	5.1-6.5	Low----------	0.15			
	25-45	6-18	1.65-1.90	<0.2	0.-0.08	5.1-6.5	Low----------	0.15			
	45-60	5-18	1.80-2.00	<0.06	0.-0.04	5.6-7.3	Low----------	0.24			
155B---------- Chetek	0-9	4-12	1.35-1.70	2.0-6.0	0.10-0.15	5.1-6.5	Low----------	0.24	3	3	1-3
	9-24	10-18	1.60-1.70	2.0-6.0	0.09-0.19	5.1-6.5	Low----------	0.24			
	24-60	1-6	1.50-1.60	>6.0	0.02-0.04	5.1-6.5	Low----------	0.10			
155C---------- Chetek	0-4	7-15	1.35-1.70	2.0-6.0	0.15-0.22	5.1-6.5	Low----------	0.32	3	5	1-3
	4-23	10-18	1.60-1.70	2.0-6.0	0.09-0.19	5.1-6.5	Low----------	0.24			
	23-60	1-6	1.50-1.60	>6.0	0.02-0.04	5.1-6.5	Low----------	0.10			
158B, 158C------- Zimmerman	0-8	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	.5-1
	8-60	2-10	1.50-1.70	6.0-20	0.06-0.10	6.1-7.3	Low----------	0.17			
159B---------- Anoka	0-9	2-10	1.40-1.60	2.0-20	0.13-0.16	5.6-6.5	Low----------	0.17	5	2	.5-1
	9-51	2-10	1.45-1.70	0.6-2.0	0.10-0.16	5.1-6.5	Low----------	0.17			
	51-60	2-5	1.45-1.75	2.0-20	0.06-0.12	6.1-7.3	Low----------	0.17			
159C---------- Anoka	0-6	2-10	1.40-1.60	2.0-20	0.13-0.16	5.6-6.5	Low----------	0.17	5	2	.5-1
	6-56	2-10	1.45-1.70	0.6-2.0	0.10-0.16	5.1-6.5	Low----------	0.17			
	56-60	2-5	1.45-1.75	2.0-20	0.06-0.12	6.1-7.3	Low----------	0.17			
161---------- Isanti	0-12	2-10	1.35-1.55	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	3-15
	12-60	1-5	1.50-1.70	6.0-20	0.05-0.07	5.6-6.5	Low----------	0.17			
162---------- Lino	0-8	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.0	Low----------	0.17	5	2	.5-2
	8-42	2-10	1.50-1.70	6.0-20	0.06-0.08	5.1-6.0	Low----------	0.17			
	42-60	2-5	1.55-1.70	6.0-20	0.05-0.07	5.6-6.5	Low----------	0.17			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
169B---------- Braham	0-8	2-8	1.40-1.60	6.0-20	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	.5-2
	8-20	2-8	1.45-1.60	6.0-20	0.08-0.10	5.6-7.3	Low----------	0.17			
	20-41	18-35	1.50-1.70	0.2-2.0	0.15-0.18	5.1-7.3	Moderate-----	0.37			
	41-60	18-35	1.55-1.80	0.2-2.0	0.15-0.18	7.4-8.4	Moderate-----	0.37			
169C---------- Braham	0-8	2-8	1.40-1.60	6.0-20	0.10-0.12	5.6-7.3	Low----------	0.17	5	2	.5-2
	8-20	2-8	1.45-1.60	6.0-20	0.08-0.10	5.6-7.3	Low----------	0.17			
	20-55	18-35	1.50-1.70	0.2-2.0	0.15-0.18	5.1-7.3	Moderate-----	0.37			
	55-60	18-35	1.55-1.80	0.2-2.0	0.15-0.18	7.4-8.4	Moderate-----	0.37			
182---------- Halder	0-12	5-15	1.35-1.55	0.6-2.0	0.11-0.22	4.5-7.3	Low----------	0.24	4	3	1-3
	12-32	18-25	1.65-1.75	0.6-2.0	0.13-0.22	4.5-6.5	Low----------	0.32			
	32-40	5-15	1.55-1.70	0.6-2.0	0.05-0.13	4.5-6.5	Low----------	0.24			
	40-60	1-5	1.55-1.70	>6.0	0.02-0.04	5.6-6.5	Low----------	0.10			
204B---------- Cushing	0-5	6-18	1.35-1.65	0.6-2.0	0.16-0.24	5.1-7.8	Low----------	0.32	5	5	1-3
	5-12	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low----------	0.32			
	12-40	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	40-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
204C---------- Cushing	0-8	6-18	1.35-1.65	0.6-2.0	0.16-0.24	5.1-7.8	Low----------	0.32	5	5	1-3
	8-14	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low----------	0.32			
	14-53	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	53-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
204D---------- Cushing	0-7	6-18	1.35-1.65	0.6-2.0	0.16-0.24	5.1-7.8	Low----------	0.32	5	5	1-3
	7-40	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	40-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
204F---------- Cushing	0-3	6-18	1.35-1.65	0.6-2.0	0.16-0.24	5.1-7.8	Low----------	0.32	5	5	1-3
	3-6	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low----------	0.32			
	6-32	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	32-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
207B---------- Nymore	0-7	2-12	1.45-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	1-3
	7-27	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.3	Low----------	0.17			
	27-60	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.8	Low----------	0.17			
207C---------- Nymore	0-4	2-12	1.45-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	1-3
	4-15	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.3	Low----------	0.17			
	15-60	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.8	Low----------	0.17			
207D---------- Nymore	0-5	2-12	1.45-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	1-3
	5-21	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.3	Low----------	0.17			
	21-60	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.8	Low----------	0.17			
207E---------- Nymore	0-4	2-12	1.45-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	1-3
	4-18	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.3	Low----------	0.17			
	18-60	0-5	1.55-1.65	6.0-20	0.02-0.08	5.1-7.8	Low----------	0.17			
265---------- Soderville	0-9	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	.5-1
	9-32	2-10	1.45-1.70	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.15			
	32-45	6-12	1.45-1.75	6.0-20	0.06-0.11	5.1-6.5	Low----------	0.15			
	45-60	2-5	1.45-1.75	6.0-20	0.05-0.10	5.1-6.5	Low----------	0.15			
274---------- Newson	0-8	4-12	1.35-1.65	2.0-6.0	0.08-0.13	3.6-6.0	Low----------	0.17	5	2	4-15
	8-32	1-4	1.50-1.65	6.0-20	0.05-0.11	3.6-5.5	Low----------	0.17			
	32-60	1-4	1.50-1.65	6.0-20	0.04-0.10	4.5-6.5	Low----------	0.17			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
292---------- Alstad	0-9	7-18	1.35-1.60	0.6-2.0	0.20-0.24	5.1-7.3	Low----------	0.37	5	5	2-4
	9-13	6-16	1.55-1.65	0.6-2.0	0.13-0.22	5.1-7.3	Low----------	0.32			
	13-25	18-35	1.55-1.65	0.6-2.0	0.14-0.22	5.1-7.3	Low----------	0.32			
	25-39	18-35	1.55-1.70	0.6-2.0	0.13-0.19	5.6-7.8	Low----------	0.32			
	39-60	8-23	1.60-1.80	0.2-0.6	0.09-0.19	6.1-8.4	Low----------	0.32			
325---------- Prebish	0-10	5-20	1.35-1.55	2.0-6.0	0.16-0.18	5.6-7.3	Low----------	0.20	5	3	4-8
	10-42	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low----------	0.28			
	42-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low----------	0.28			
328B---------- Sartell	0-8	1-6	1.30-1.45	6.0-20	0.09-0.11	5.1-6.0	Low----------	0.15	5	1	.5-2
	8-25	0-5	1.50-1.65	6.0-20	0.06-0.10	5.1-6.0	Low----------	0.15			
	25-60	0-5	1.50-1.65	6.0-20	0.05-0.09	5.6-7.3	Low----------	0.15			
328C---------- Sartell	0-5	1-6	1.30-1.45	6.0-20	0.09-0.11	5.1-6.0	Low----------	0.15	5	1	.5-2
	5-29	0-5	1.50-1.65	6.0-20	0.06-0.10	5.1-6.0	Low----------	0.15			
	29-60	0-5	1.50-1.65	6.0-20	0.05-0.09	5.6-7.3	Low----------	0.15			
328D---------- Sartell	0-4	1-6	1.30-1.45	6.0-20	0.09-0.11	5.1-6.0	Low----------	0.15	5	1	.5-2
	4-26	0-5	1.50-1.65	6.0-20	0.06-0.10	5.1-6.0	Low----------	0.15			
	26-60	0-5	1.50-1.65	6.0-20	0.05-0.09	5.6-7.3	Low----------	0.15			
337---------- Warman	0-10	4-18	0.80-1.40	0.6-6.0	0.19-0.25	4.5-6.0	Low----------	0.24	4	5	7-20
	10-34	4-18	1.20-1.45	0.6-2.0	0.15-0.20	5.1-7.3	Low----------	0.32			
	34-60	0-5	1.55-1.75	>6.0	0.01-0.08	6.1-7.3	Low----------	0.10			
346---------- Talmoon	0-9	8-20	1.10-1.35	0.6-2.0	0.20-0.22	5.1-7.3	Low----------	0.28	5	5	2-4
	9-12	15-27	1.20-1.40	0.6-2.0	0.13-0.22	5.1-7.3	Low----------	0.37			
	12-24	18-35	1.40-1.60	0.2-0.6	0.16-0.19	5.6-7.3	Moderate-----	0.37			
	24-60	15-35	1.40-1.60	0.2-0.6	0.15-0.19	7.4-8.4	Moderate-----	0.37			
454B---------- Mahtomedi	0-8	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	8-22	0-10	1.40-1.50	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.10			
	22-40	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
454C---------- Mahtomedi	0-8	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	8-29	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
454D---------- Mahtomedi	0-4	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	4-12	0-10	1.40-1.50	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.10			
	12-34	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
454F---------- Mahtomedi	0-3	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	3-9	0-10	1.40-1.50	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.10			
540---------- Seelyeville	0-32	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-7.8	----------	----	5	2	55-85
	32-60	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-7.8	----------	----			
543---------- Markey	0-30	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8	----------	----	4	2	55-85
	30-60	0-10	1.40-1.65	6.0-20	0.03-0.08	5.6-8.4	Low----------	----			
544---------- Cathro	0-38	---	0.28-0.45	0.2-6.0	0.45-0.55	4.5-7.8	----------	----	5	2	55-85
	38-60	10-25	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low----------	----			
545---------- Rondeau	0-39	---	0.10-0.25	0.2-6.0	0.35-0.48	5.1-7.8	----------	----	5	2	55-85
	39-60	5-15	0.05-0.20	<0.2	0.20-0.22	7.4-8.4	----------	----			
565---------- Eckvoll	0-8	5-15	1.30-1.70	2.0-6.0	0.10-0.12	6.1-7.3	Low----------	0.17	5	2	1-3
	8-24	2-10	1.30-1.70	2.0-6.0	0.06-0.08	6.1-7.3	Low----------	0.15			
	24-45	18-35	1.40-1.70	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.37			
	45-60	18-32	1.30-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.37			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
676B---------- Kost	0-17	3-10	1.20-1.40	2.0-6.0	0.09-0.12	5.1-7.3	Low----------	0.17	5	2	1-2
	17-29	0-5	1.40-1.60	6.0-20	0.06-0.08	5.1-7.3	Low----------	0.15			
	29-60	0-5	1.40-1.60	6.0-20	0.05-0.07	5.6-7.3	Low----------	0.15			
677---------- Siren	0-2	15-25	1.35-1.45	0.6-2.0	0.15-0.24	5.1-6.5	Low----------	0.32	5	5	3-4
	2-6	5-10	1.40-1.60	0.6-2.0	0.09-0.22	5.1-6.5	Low----------	0.24			
	6-34	40-70	1.60-1.70	0.06-0.6	0.09-0.13	5.1-7.8	Moderate-----	0.28			
	34-60	40-70	1.65-1.70	0.06-0.6	0.08-0.12	6.1-8.4	Moderate-----	0.28			
678---------- Beltrami	0-8	6-18	1.30-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	5	2-4
	8-11	5-15	1.40-1.65	0.6-6.0	0.11-0.19	5.1-7.3	Low----------	0.32			
	11-32	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32			
	32-60	18-30	1.50-1.70	0.6-2.0	0.15-0.19	6.1-7.3	Low----------	0.32			
682B---------- Milaca	0-6	8-15	1.40-1.60	2.0-6.0	0.13-0.18	5.1-6.5	Low----------	0.20	3	8	.5-1
	6-16	8-15	1.40-1.60	2.0-6.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	16-24	8-18	1.45-1.65	0.6-2.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	24-35	8-18	1.75-1.90	<0.2	0.-0.08	5.6-7.3	Low----------	0.28			
	35-60	6-18	1.80-2.00	<0.06	0.-0.04	6.1-7.3	Low----------	0.28			
682C---------- Milaca	0-6	8-15	1.40-1.60	2.0-6.0	0.13-0.18	5.1-6.5	Low----------	0.20	3	8	.5-1
	6-15	8-15	1.40-1.60	2.0-6.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	15-23	8-18	1.45-1.65	0.6-2.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	23-35	8-18	1.75-1.90	<0.2	0.-0.08	5.6-7.3	Low----------	0.28			
	35-60	6-18	1.80-2.00	<0.06	0.-0.04	6.1-7.3	Low----------	0.28			
682D---------- Milaca	0-6	8-15	1.40-1.60	2.0-6.0	0.13-0.18	5.1-6.5	Low----------	0.20	3	8	.5-1
	6-14	8-15	1.40-1.60	2.0-6.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	14-25	8-18	1.45-1.65	0.6-2.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	25-40	8-18	1.75-1.90	<0.2	0.-0.08	5.6-7.3	Low----------	0.28			
	40-60	6-18	1.80-2.00	<0.06	0.-0.04	6.1-7.3	Low----------	0.28			
682E---------- Milaca	0-4	8-15	1.40-1.60	2.0-6.0	0.13-0.18	5.1-6.5	Low----------	0.20	3	8	.5-1
	4-16	8-15	1.40-1.60	2.0-6.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	16-22	8-18	1.45-1.65	0.6-2.0	0.12-0.16	5.1-6.5	Low----------	0.28			
	22-40	8-18	1.75-1.90	<0.2	0.-0.08	5.6-7.3	Low----------	0.28			
	40-60	6-18	1.80-2.00	<0.06	0.-0.04	6.1-7.3	Low----------	0.28			
717B---------- Novak	0-8	10-25	1.20-1.40	0.6-2.0	0.22-0.24	5.1-6.5	Low----------	0.37	4	5	2-4
	8-17	10-25	1.35-1.55	0.6-2.0	0.20-0.22	5.1-6.5	Low----------	0.37			
	17-34	18-30	1.35-1.55	0.6-2.0	0.16-0.22	5.1-6.5	Moderate-----	0.37			
	34-38	12-18	1.45-1.65	0.6-6.0	0.10-0.19	5.1-6.5	Low----------	0.28			
	38-60	1-8	1.50-1.70	>6.0	0.02-0.04	5.1-7.8	Low----------	0.10			
722---------- Blomford	0-8	2-8	1.40-1.60	6.0-2.0	0.08-0.12	5.1-7.3	Low----------	0.17	5	2	1-4
	8-24	2-5	1.45-1.70	6.0-2.0	0.06-0.09	5.1-7.3	Low----------	0.17			
	24-37	18-35	1.45-1.60	0.6-2.0	0.16-0.22	5.1-7.3	Moderate-----	0.43			
	37-60	10-30	1.45-1.60	0.6-2.0	0.16-0.22	6.1-8.4	Moderate-----	0.43			
726---------- Kratka	0-10	2-10	1.20-1.50	6.0-20	0.10-0.12	6.1-7.3	Low----------	0.17	5	2	1-3
	10-30	2-10	1.30-1.60	6.0-20	0.06-0.11	6.1-7.3	Low----------	0.17			
	30-60	10-35	1.50-1.80	0.2-2.0	0.11-0.19	6.1-7.3	Moderate-----	0.32			
792---------- Fordum	0-26	8-15	1.35-1.50	0.6-6.0	0.11-0.18	5.6-8.4	Low----------	0.20	4	8	3-12
	26-40	8-18	1.40-1.50	0.6-6.0	0.10-0.22	5.6-8.4	Low----------	0.43			
	40-60	2-5	1.55-1.70	6.0-20	0.04-0.10	5.6-8.4	Low----------	0.15			
928B:											
Mahtomedi-------	0-8	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	8-40	0-10	1.40-1.50	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.10			
	40-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
928B:											
Cushing---------	0-5	6-18	1.35-1.65	0.6-2.0	0.16-0.24	5.1-7.8	Low----------	0.32	5	5	1-3
	5-12	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low----------	0.32			
	12-40	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	40-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
928C:											
Mahtomedi-------	0-8	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	8-29	0-10	1.40-1.50	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.10			
	29-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
Cushing---------	0-8	6-18	1.35-1.65	0.6-2.0	0.16-0.24	5.1-7.8	Low----------	0.32	5	5	1-3
	8-14	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low----------	0.32			
	14-53	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	53-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
928D:											
Mahtomedi-------	0-4	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
	4-34	0-10	1.40-1.50	6.0-20	0.06-0.08	5.1-6.5	Low----------	0.10			
	34-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
Cushing---------	0-7	6-18	1.35-1.65	0.6-2.0	0.16-0.24	5.1-7.8	Low----------	0.32	5	5	1-3
	7-40	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low----------	0.32			
	40-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low----------	0.32			
1030:											
Udorthents.											
Pits.											
1068---------- Caryville	0-10	5-15	1.35-1.55	2.0-6.0	0.12-0.18	5.6-7.3	Low----------	0.20	3	3	1-4
	10-60	5-10	1.55-1.70	2.0-20	0.04-0.10	5.1-7.3	Low----------	0.15			
1069C:											
Fairport--------	0-8	12-20	1.35-1.50	0.6-2.0	0.20-0.24	5.6-7.8	Low----------	0.37	4	5	1-3
	8-24	18-27	1.45-1.70	0.6-2.0	0.10-0.20	7.4-8.4	Low----------	0.37			
	24	---	---	---	---	---	----------	----			
Rock outcrop.											
1070D:											
Plainbo---------	0-5	5-15	1.35-1.65	2.0-6.0	0.10-0.13	3.6-6.5	Low----------	0.17	4	2	<1
	5-23	1-10	1.50-1.65	6.0-20	0.06-0.11	3.6-6.5	Low----------	0.15			
	23	---	---	---	---	---	----------	----			
Rock outcrop.											
1977---------- Mora	0-4	7-18	1.30-1.60	2.0-6.0	0.14-0.16	5.1-6.5	Low----------	0.20	4	8	.5-3
	4-12	6-18	1.30-1.60	0.6-6.0	0.14-0.20	5.1-6.5	Low----------	0.28			
	12-30	8-18	1.50-1.70	0.6-2.0	0.15-0.19	5.6-6.5	Low----------	0.28			
	30-50	4-18	1.70-1.90	<0.2	0.-0.08	5.6-6.5	Low----------	0.28			
	50-60	4-18	1.80-2.00	<0.06	0.-0.04	5.6-7.8	Low----------	0.28			
1980---------- Ronneby	0-7	7-18	1.40-1.60	2.0-6.0	0.13-0.17	5.1-6.5	Low----------	0.17	4	8	1-4
	7-19	5-18	1.30-1.60	0.6-6.0	0.12-0.19	5.1-6.5	Low----------	0.28			
	19-35	6-18	1.45-1.75	0.6-2.0	0.12-0.19	5.6-6.5	Low----------	0.28			
	35-44	4-18	1.70-1.90	0.06-0.2	0.03-0.08	6.1-7.3	Low----------	0.28			
	44-60	4-18	1.80-2.00	<0.06	0.-0.04	6.1-8.4	Low----------	0.28			

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "frequent," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness			Uncoated steel	Concrete
					Ft			In		In			
40B, 40C, 40D, 40F----------Nebish	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
75----------Bluffton	C/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	---	High-----	High-----	Moderate.
119B, 119C------Pomroy	C	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Moderate	Low.
155B, 155C------Chetek	B	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	High.
158B, 158C------Zimmerman	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	High.
159B, 159C------Anoka	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Moderate.
161----------Isanti	A/D	None--------	---	---	0-2.0	Apparent	Oct-Jun	>60	---	---	Moderate	High-----	Moderate.
162----------Lino	B	None--------	---	---	2.0-4.0	Apparent	Oct-Jun	>60	---	---	Moderate	Low------	High.
169B, 169C------Braham	B	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate.
182----------Halder	C	None--------	---	---	1.0-2.5	Apparent	Oct-Jun	>60	---	---	High-----	Moderate	Moderate.
204B, 204C, 204D, 204F-----Cushing	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Moderate.
207B, 207C, 207D, 207E-----Nymore	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate.
265----------Soderville	A	None--------	---	---	2.0-4.0	Perched	Oct-Jun	>60	---	---	Moderate	Low------	Moderate.
274----------Newson	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	---	Moderate	High-----	High.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hard-ness	Total subsi-dence	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In		In			
292---------- Alstad	C	None--------	---	---	2.0-4.0	Apparent	Mar-Jun	>60	---	---	High-----	Moderate	Moderate.
325---------- Prebish	C/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	---	High-----	High-----	Low.
328B, 328C, 328D---------- Sartell	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate.
337---------- Warman	B/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	---	High-----	High-----	High.
346---------- Talmoon	C	None--------	---	---	1.0-3.0	Apparent	Oct-Jun	>60	---	---	High-----	High-----	Moderate.
454B, 454C, 454D, 454F----- Mahtomedi	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	High.
540---------- Seelyeville	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	40-50	High-----	High-----	Low.
543---------- Markey	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	25-30	High-----	High-----	Low.
544---------- Cathro	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	25-30	High-----	High-----	Low.
545---------- Rondeau	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	25-30	High-----	High-----	Low.
565---------- Eckvoll	B	None--------	---	---	2.0-5.0	Apparent	Oct-Jun	>60	---	---	High-----	Moderate	Low.
676B---------- Kost	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate.
677---------- Siren	C	None--------	---	---	1.0-3.0	Perched	Oct-Jun	>60	---	---	High-----	High-----	Moderate.
678---------- Beltrami	B	None--------	---	---	2.0-4.0	Apparent	Oct-Jun	>60	---	---	High-----	Moderate	Low.
682B, 682C, 682D, 682E----- Milaca	C	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Moderate.
717B---------- Novak	B	None--------	---	---	>6.0	---	---	>60	---	---	High-----	Low------	Moderate.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Total subsidence	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In		In			
722 Blomford	B/D	None	---	---	0.5-1.5	Apparent	Oct-Jun	>60	---	---	Moderate	High	Moderate.
726 Kratka	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	---	Moderate	High	Low.
792 Fordum	D	Frequent	Brief or long.	Mar-Jun	+1-1.0	Apparent	Jan-Dec	>60	---	---	High	High	High.
928B, 928C, 928D:													
Mahtomedi	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	High.
Cushing	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Moderate.
1030:													
Udorthents.													
Pits.													
1068 Caryville	B	Occasional	Brief	Mar-Jun	4.0-6.0	Apparent	Oct-Jun	>60	---	---	Low	Moderate	Moderate.
1069C:													
Fairport	C	None	---	---	>6.0	---	---	20-40	Hard	---	Moderate	Moderate	Low.
Rock outcrop.													
1070D:													
Plainbo	A	None	---	---	>6.0	---	---	20-40	Hard	---	Low	Low	Moderate.
Rock outcrop.													
1977 Mora	C	None	---	---	2.0-3.0	Perched	Oct-Jun	>60	---	---	High	Moderate	Moderate.
1980 Ronneby	C	None	---	---	1.5-3.0	Perched	Oct-Jun	>60	---	---	High	Moderate	Moderate.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Alstad	Fine-loamy, mixed Glossaquic Eutroboralfs
*Anoka	Coarse-loamy, mixed Eutric Glossoboralfs
Beltrami	Fine-loamy, mixed Aquic Eutroboralfs
Bluffton	Fine-loamy, mixed, frigid Typic Haplaquolls
Braham	Loamy, mixed Arenic Eutroboralfs-
Caryville	Sandy, mixed Fluventic Haploborolls
Cathro	Loamy, mixed, euic Terric Borosaprists
Chetek	Coarse-loamy, mixed Eutric Glossoboralfs
Cushing	Fine-loamy, mixed Glossic Eutroboralfs
Eckvoll	Loamy, mixed Aquic Arenic Eutroboralfs
Fairport	Fine-loamy, mixed Typic Eutroboralfs
*Fordum	Coarse-loamy, mixed, nonacid, frigid Mollic Fluvaquents
Halder	Fine-loamy over sandy or sandy-skeletal, mixed Aquic Glossoboralfs
Isanti	Sandy, mixed, frigid Typic Haplaquolls
Kost	Sandy, mixed Udorthentic Haploborolls
Kratka	Sandy over loamy, mixed, frigid Typic Haplaquolls
Lino	Mixed, frigid Aquic Udipsamments
Mahtomedi	Mixed, frigid Typic Udipsamments
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
*Milaca	Coarse-loamy, mixed Typic Eutroboralfs
Mora	Coarse-loamy, mixed Aquic Eutroboralfs
Nebish	Fine-loamy, mixed Typic Eutroboralfs
Newson	Mixed, frigid Humaqueptic Psammaquents
Novak	Fine-silty over sandy or sandy-skeletal, mixed Mollic Eutroboralfs
Nymore	Mixed, frigid Typic Udipsamments
Plainbo	Mixed, frigid Typic Udipsamments
Pomroy	Loamy, mixed Arenic Eutroboralfs
Prebish	Coarse-loamy, mixed, frigid Typic Haplaquolls
Rondeau	Marly, euic Limnic Borosaprists
Ronneby	Coarse-loamy, mixed, frigid Udollic Ochraqualfs
Sartell	Mixed, frigid Typic Udipsamments
Seelyeville	Euic Typic Borosaprists
Siren	Fine, mixed Glossaquic Eutroboralfs
Soderville	Sandy, mixed Aquic Glossoboralfs
Talmoon	Fine-loamy, mixed, frigid Mollic Ochraqualfs
Udorthents	Udorthents
Warman	Coarse-loamy over sandy or sandy-skeletal, mixed, frigid Typic Haplaquolls
Zimmerman	Mixed, frigid Alfic Udipsamments

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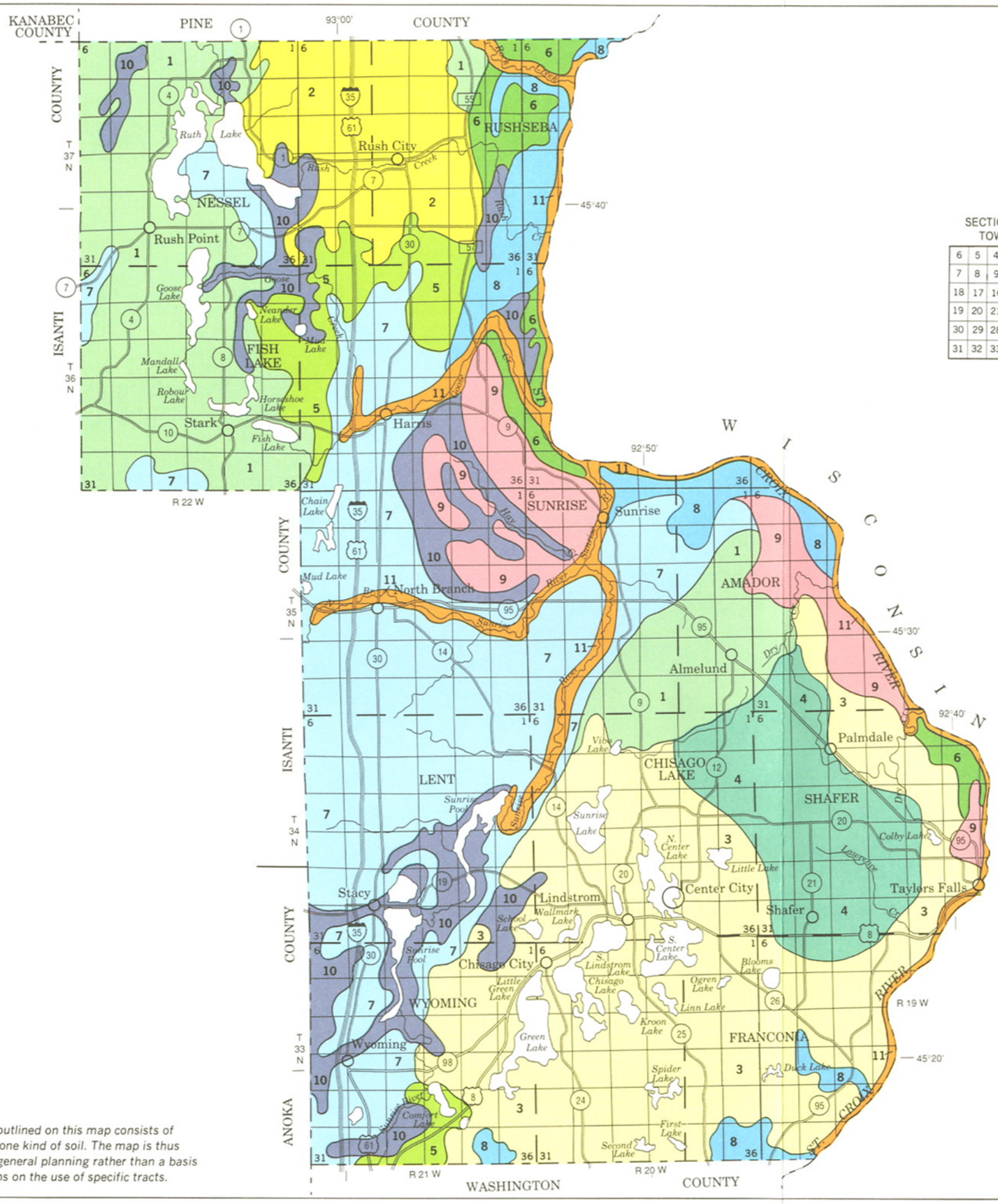


SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND*

- 1 Cushing-Talmoon association
- 2 Alstad-Talmoon association
- 3 Nebish-Talmoon association
- 4 Beltrami-Talmoon association
- 5 Braham-Blomford-Eckvoll association
- 6 Milaca-Ronneby association
- 7 Zimmerman-Isanti association
- 8 Mahtomedi-Pomroy association
- 9 Nymore-Lino association
- 10 Seeleyville-Markey association
- 11 Fordum-Caryville association

* The units on this legend are described in the text under the heading "General Soil Map Units."

Compiled 1990

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

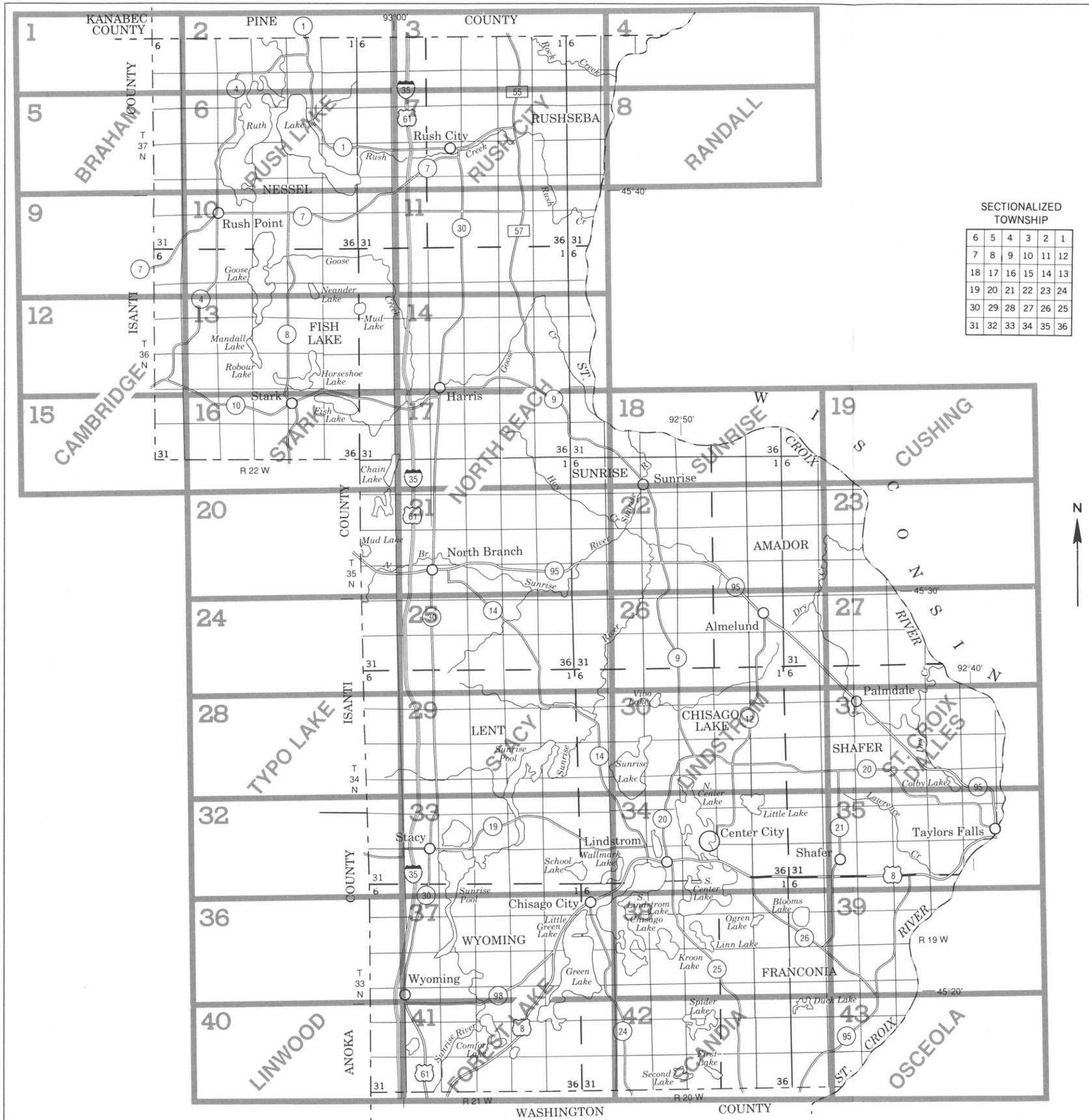
CHISAGO COUNTY, MINNESOTA

Scale 1:190,080

1 0 1 2 3 Mi

1 0 3 6 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

CHISAGO COUNTY, MINNESOTA

Scale 1:190,080

1 0 1 2 3 Mi

1 0 3 6 Km

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
40B	Nebish loam, 2 to 6 percent slopes
40C	Nebish loam, 6 to 12 percent slopes
40D	Nebish loam, 12 to 25 percent slopes
40F	Nebish loam, 25 to 40 percent slopes
75	Bluffton loam
119B	Pomroy loamy fine sand, 1 to 6 percent slopes
119C	Pomroy loamy fine sand, 6 to 12 percent slopes
155B	Chetek sandy loam, 1 to 6 percent slopes
155C	Chetek loam, 6 to 12 percent slopes
158B	Zimmerman loamy fine sand, 1 to 6 percent slopes
158C	Zimmerman loamy fine sand, 6 to 12 percent slopes
159B	Anoka loamy very fine sand, 1 to 6 percent slopes
159C	Anoka loamy fine sand, 6 to 12 percent slopes
161	Isanti loamy fine sand
162	Lino loamy fine sand
169B	Braham loamy fine sand, 2 to 6 percent slopes
169C	Braham loamy fine sand, 6 to 12 percent slopes
182	Halder sandy loam
204B	Cushing loam, 2 to 6 percent slopes
204C	Cushing loam, 6 to 12 percent slopes
204D	Cushing loam, 12 to 20 percent slopes
204F	Cushing loam, 20 to 35 percent slopes
207B	Nymore loamy sand, 1 to 6 percent slopes
207C	Nymore loamy sand, 6 to 12 percent slopes
207D	Nymore loamy sand, 12 to 18 percent slopes
207E	Nymore loamy sand, 18 to 25 percent slopes
265	Soderville loamy fine sand
274	Newson mucky loamy sand
292	Alstad loam
325	Prebish sandy loam
328B	Sartell fine sand, 1 to 6 percent slopes
328C	Sartell fine sand, 6 to 12 percent slopes
328D	Sartell fine sand, 12 to 25 percent slopes
337	Warman loam
346	Talmoon loam
454B	Mahtomedi loamy sand, 1 to 6 percent slopes
454C	Mahtomedi loamy sand, 6 to 12 percent slopes
454D	Mahtomedi loamy sand, 12 to 20 percent slopes
454F	Mahtomedi loamy sand, 20 to 35 percent slopes
540	Seelyeville muck
543	Markey muck
544	Cathro muck
545	Rondeau muck
565	Eckvoll loamy sand
676B	Kost loamy fine sand, 1 to 6 percent slopes
677	Siren silt loam
678	Beltrami loam, thick solum
682B	Milaca sandy loam, 2 to 6 percent slopes, very stony
682C	Milaca sandy loam, 6 to 12 percent slopes, very stony
682D	Milaca sandy loam, 12 to 18 percent slopes, very stony
682E	Milaca sandy loam, 18 to 25 percent slopes, very stony
717B	Novak silt loam, 0 to 6 percent slopes
722	Blomford loamy sand, lacustrine substratum
726	Kratka loamy fine sand, thick solum
792	Fordum sandy loam, frequently flooded
928B	Mahtomedi-Cushing complex, 2 to 6 percent slopes
928C	Mahtomedi-Cushing complex, 6 to 12 percent slopes
928D	Mahtomedi-Cushing complex, 12 to 20 percent slopes
1030	Udorthents-Pits, gravel, complex
1068	Caryville sandy loam, occasionally flooded
1069C	Fairport-Rock outcrop complex, 2 to 12 percent slopes
1070D	Plainbo-Rock outcrop complex, 12 to 40 percent slopes
1977	Mora loam, very stony
1980	Ronneby loam, extremely stony

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Reservation (national forest or park, state forest or park, and large airport)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK — 2 350 000 FEET

LAND DIVISION CORNERS (sections and land grants)

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 35
- Federal — 8
- State — 95

DAMS

- Medium or small — water; w

PITS

- Gravel pit

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 292 204B

ESCARPMENTS

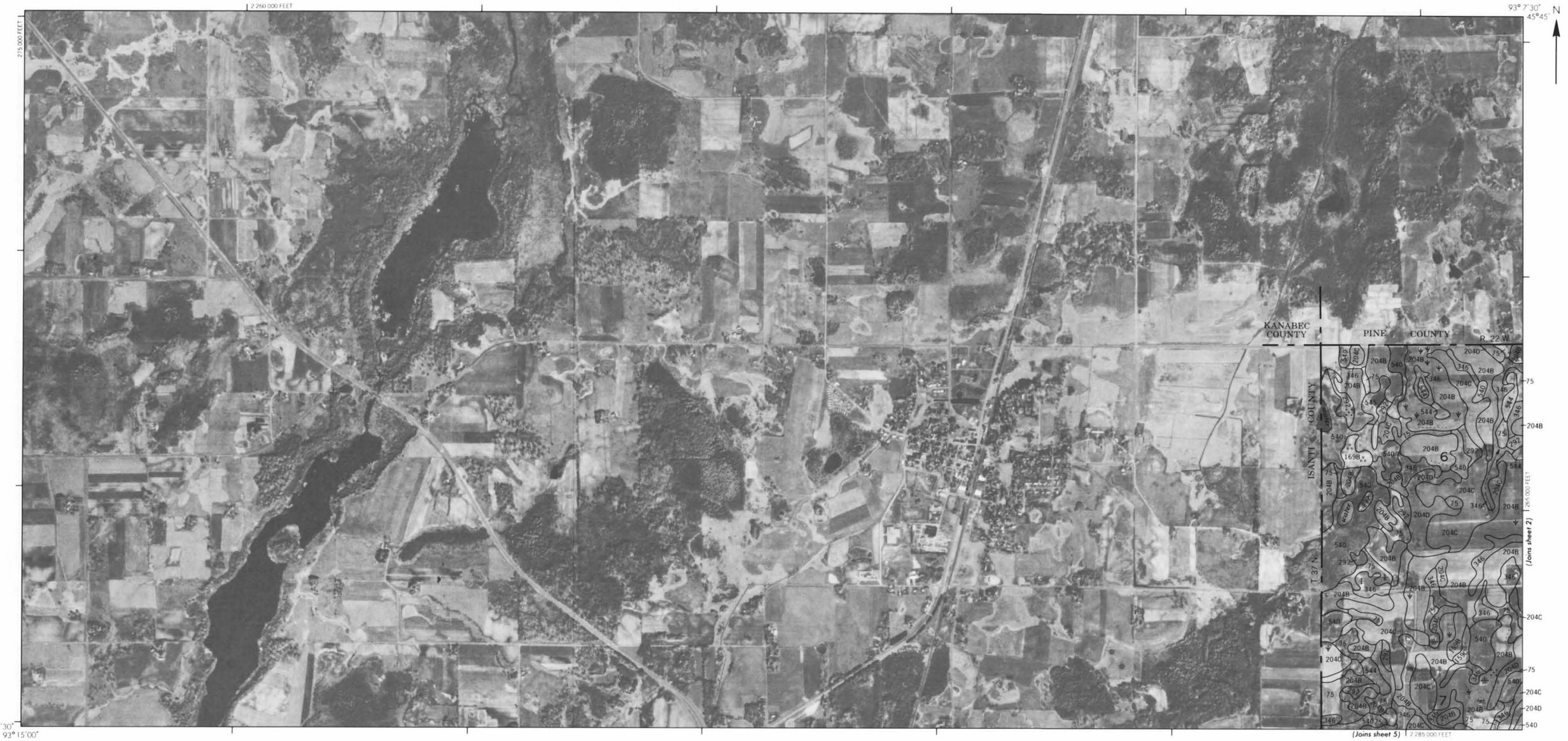
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

MISCELLANEOUS

- Gravelly spot
- Rock outcrop (includes sandstone and shale)
- Sandy spot
- Stony spot
- Better drained rise in wet area

1



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

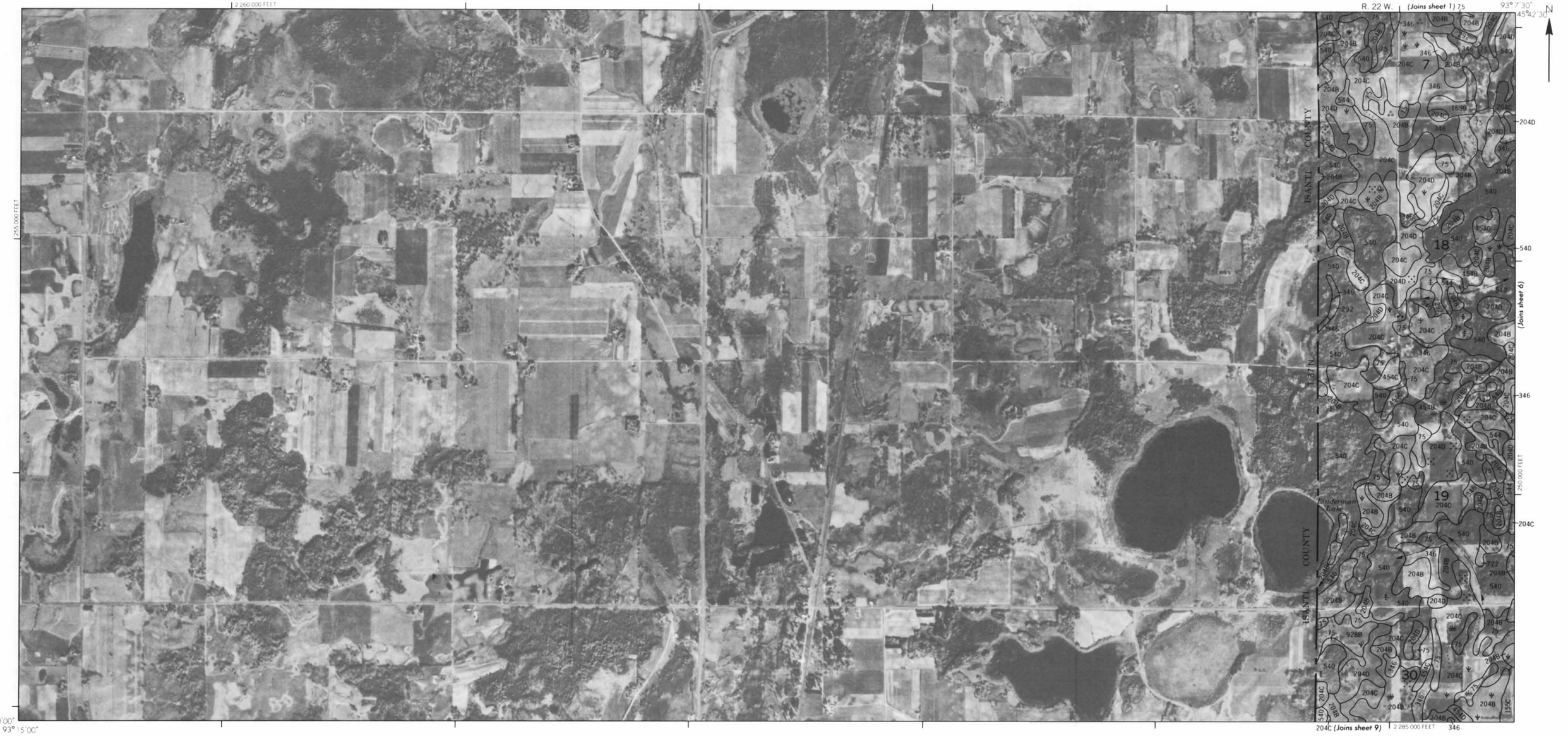
1 0.5 0 1 KILOMETER

SCALE 1:20 000

3
2 320 000 FEET
275 000 FEET
92°52'30"
45°45'
N
PINE COUNTY
R. 21 W.
R. 20 W.
PINE COUNTY
CHENGWATANA
STATE
FOREST
T. 37 N.
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 7)
265 000 FEET
2 350 000 FEET
45°42'30"
93°00'00"
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

N
45°45'00"
92°52'30"
2 380 000 FEET
275 000 FEET
R. 20 W.
PINE COUNTY
WISCONSIN
BURNETT COUNTY
CHENGWATANA STATE FOREST
RIVER
ST. CROIX
Rock Creek
T. 37 N.
265 000 FEET
(Joins sheet 3)
(Joins sheet 8)
2 355 000 FEET
45°42'30"
92°45'00"
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

5



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

N
93°7'30"
45°42'30"
(Joins sheet 2)
R. 22 W. | R. 21 W.
2 315 000 FEET
260 000 FEET
T. 37 N.
(Joins sheet 5)
(Joins sheet 7)
250 000 FEET
2 290 000 FEET
(Joins sheet 10)
45°40'00"
93°00'00"
RUSH LAKE
Rush Lake
Pine Lake
Rush Creek
Stauffer Lake
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

7
N
R. 21 W.
R. 20 W.
(Joins sheet 3)
(Joins sheet 6)
(Joins sheet 8)
(Joins sheet 11)
T. 37 N.
93° 52'30"
45°42'30"
45°40'00"
93°00'00"
2 320 000 FEET
2 350 000 FEET
260 000 FEET
250 000 FEET
Rush City Airport
Sewage Disposal Ponds
RUSH CITY
Rush Creek
BURLINGTON NORTHERN
CHENGWATANA STATE FOREST
BURNETT COUNTY WISCONSIN
St Croix River
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

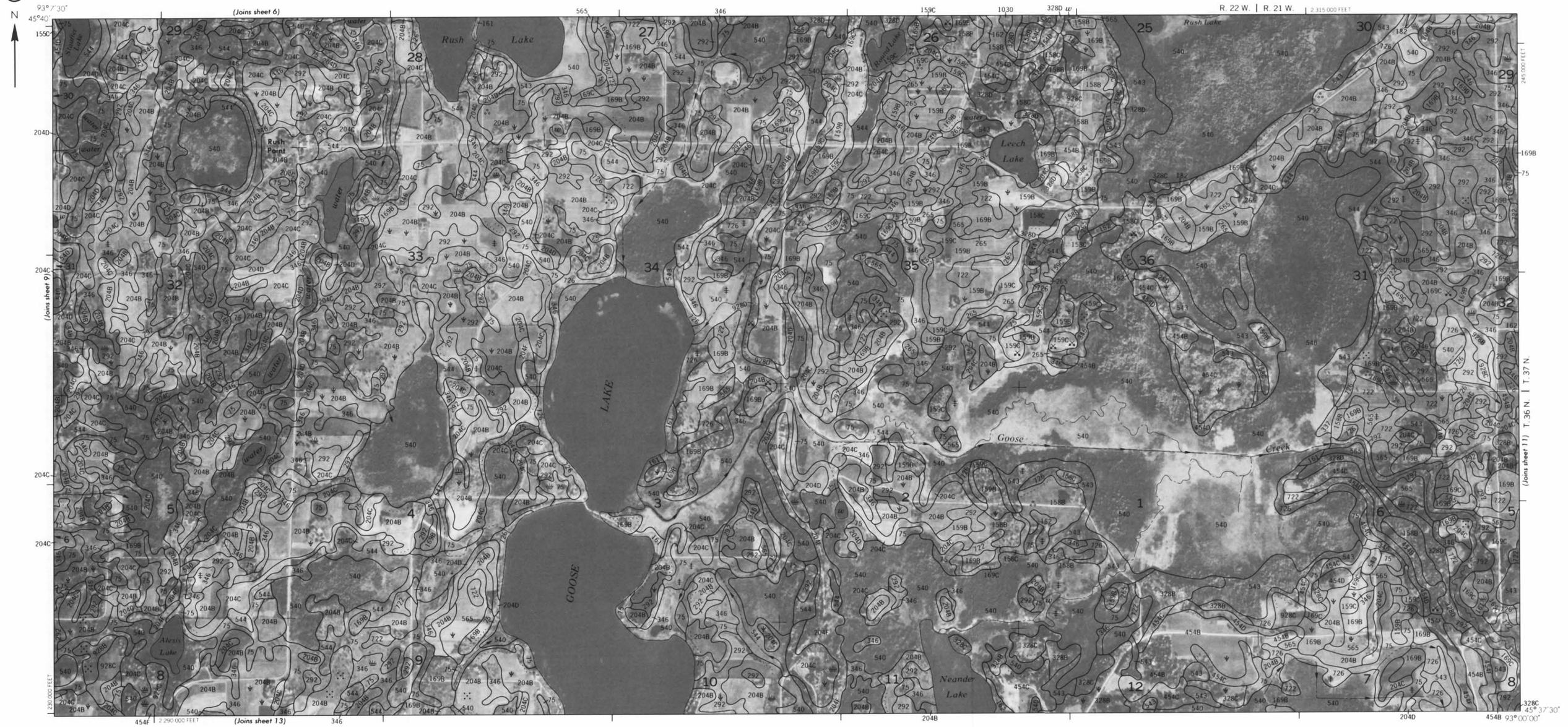
SOIL SURVEY OF CHISAGO COUNTY, MINNESOTA — SHEET NUMBER 8

R. 20 W.
92°52'30"
N 45°42'30"
(Joins sheet 4)
(Joins sheet 7)
119C
454B
337
2 380 000 FEET
260 000 FEET
250 000 FEET
2 355 000 FEET
45°40'00"
92°45'00"
ST. CROIX RIVER
WISCONSIN
MINNESOTA
COUNTY
T. 37 N.
8
17
207B
717B
274A
717B
717B
717B

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000


N
93°7'30"
45°40'
(Joins sheet 6)
R. 22 W. | R. 21 W.
2 315 000 FEET
245 000 FEET
(Joins sheet 9)
(Joins sheet 11)
T. 37 N.
T. 36 N.
230 000 FEET
2 290 000 FEET
(Joins sheet 13)
45°37'30"
93°00'00"
Rush Lake
Rush Point
Leech Lake
Round Lake
Alexis Lake
Neander Lake
GOOSE LAKE
Goose Creek
water
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

2 320 000 FEET
245 000 FEET
R. 21 W.
R. 20 W.
(Joins sheet 7)
92° 52'30"
45° 40'
N
T. 37 N.
T. 36 N.
(Joins sheet 10)
(Joins sheet 14)
2 350 000 FEET
235 000 FEET
45° 37'30"
93° 00'00"
NORTHERN
BURLINGTON
ST CROIX STATE PARK
WILD RIVER
CHENGWATANA STATE FOREST
ST CROIX RIVER
WISCONSIN
BURNETT COUNTY
POLK COUNTY
Rush Creek
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

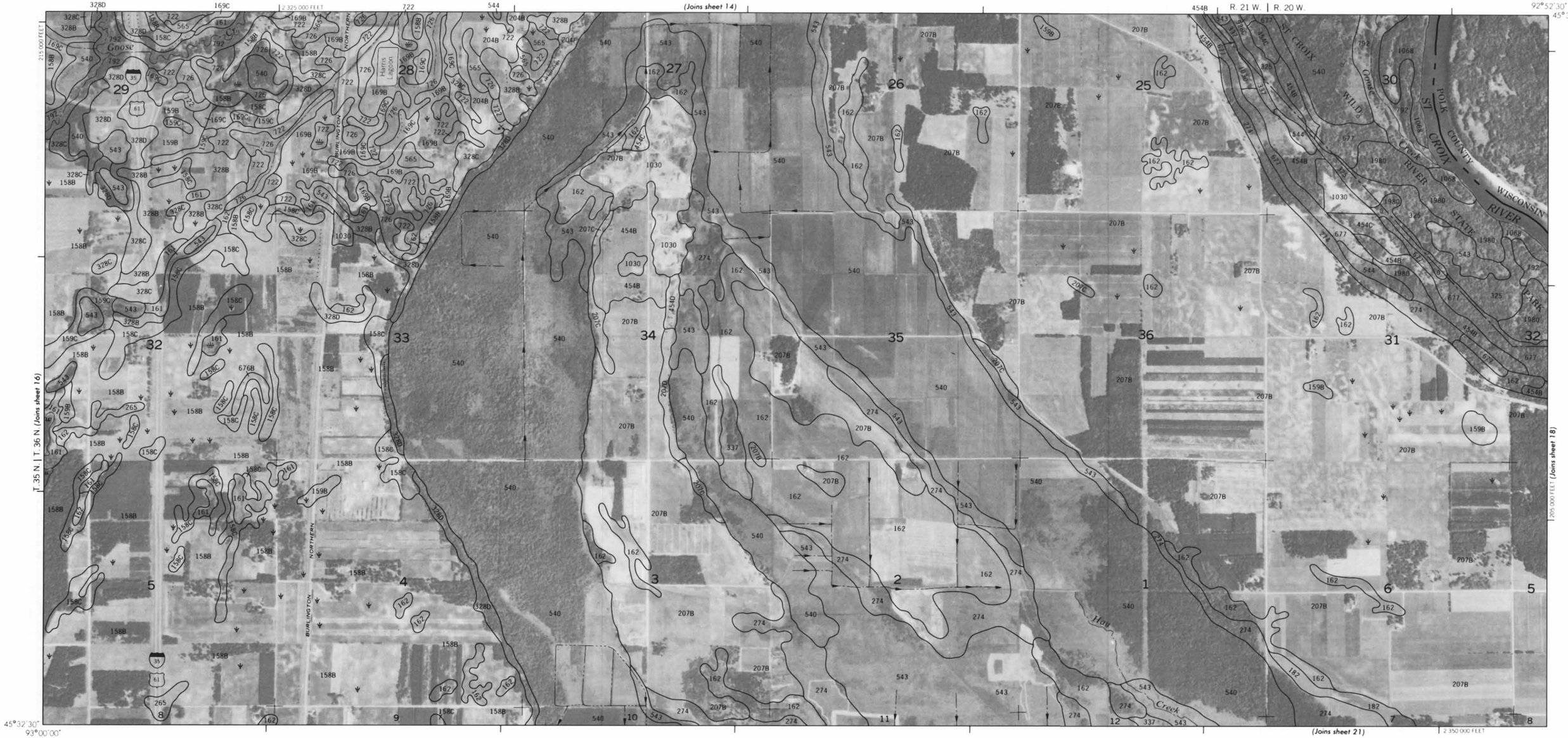
SCALE 1:20 000

2 260 000 FEET
R. 22 W. (Joins sheet 12)
93°7'30"
45°35'
N
210 000 FEET
(Joins sheet 16)
565
200 000 FEET
45°32'30"
93°15'00"
2 285 000 FEET
ISANTI COUNTY
T. 36 N.
30
31
Stegman Lake
water
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000



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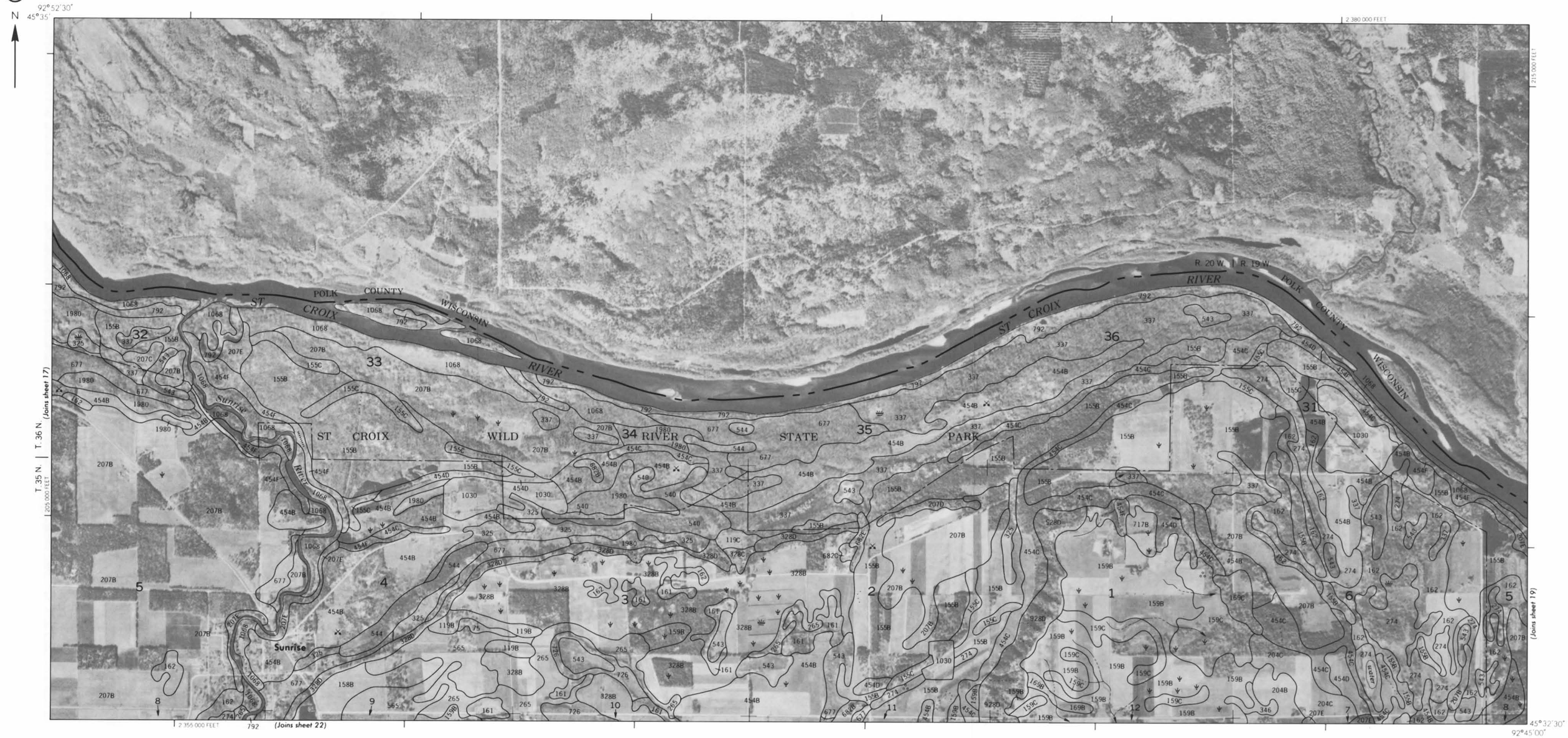
1 0.5 0 1 KILOMETER

SCALE 1:20 000



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

92° 37'30"
45° 35'
N
2 385 000 FEET
215 000 FEET
205 000 FEET
2 415 000 FEET
45°32'30"
92°45'00"
T. 35 N.
(Joins sheet 18)
(Joins sheet 23)
R. 19 W.
POLK COUNTY
WISCONSIN
ST CROIX RIVER
ST CROIX WILD RIVER STATE PARK
1068
454F
207B
155B
162
5
8
4
9
540
1 MILE
1 KILOMETER
SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

23

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

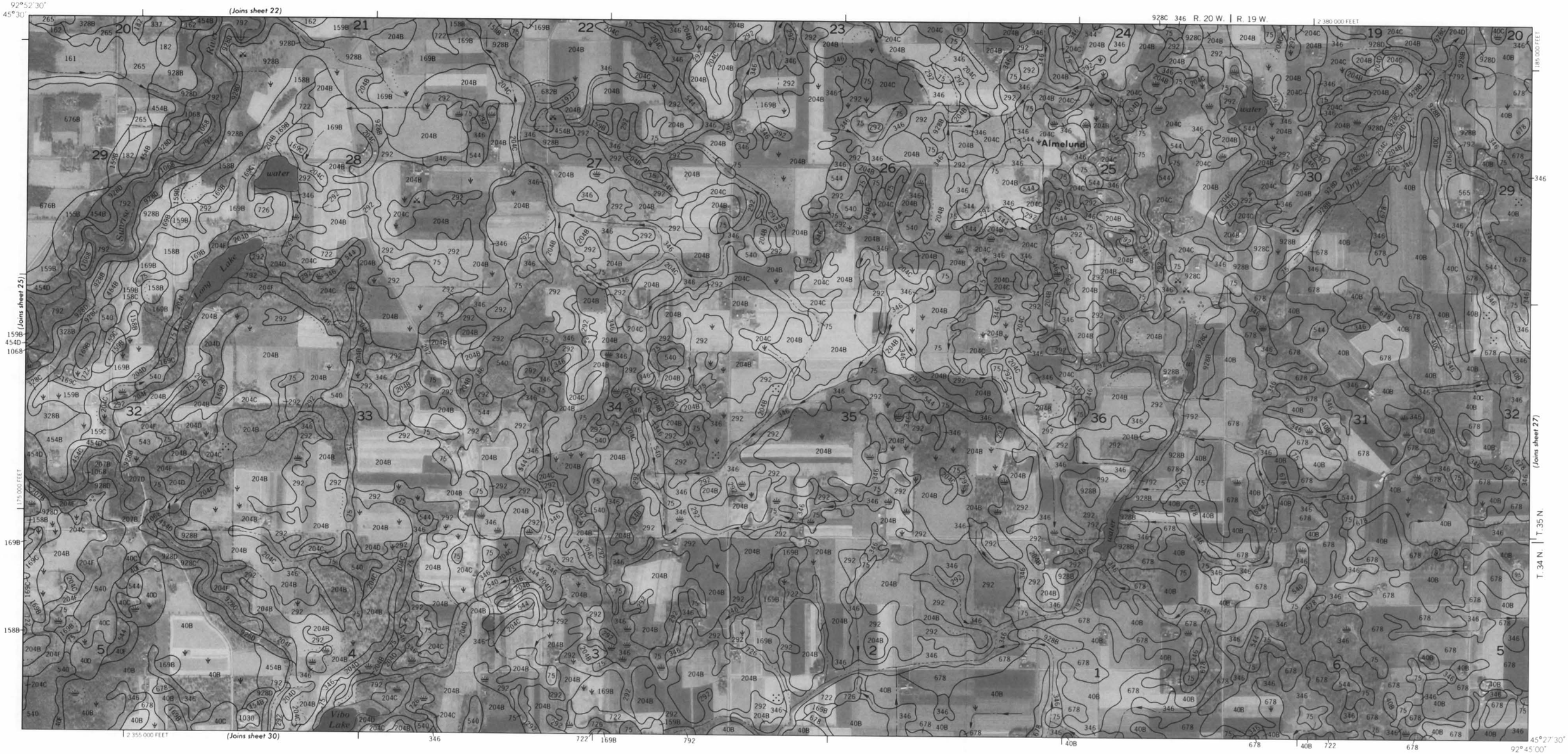
1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

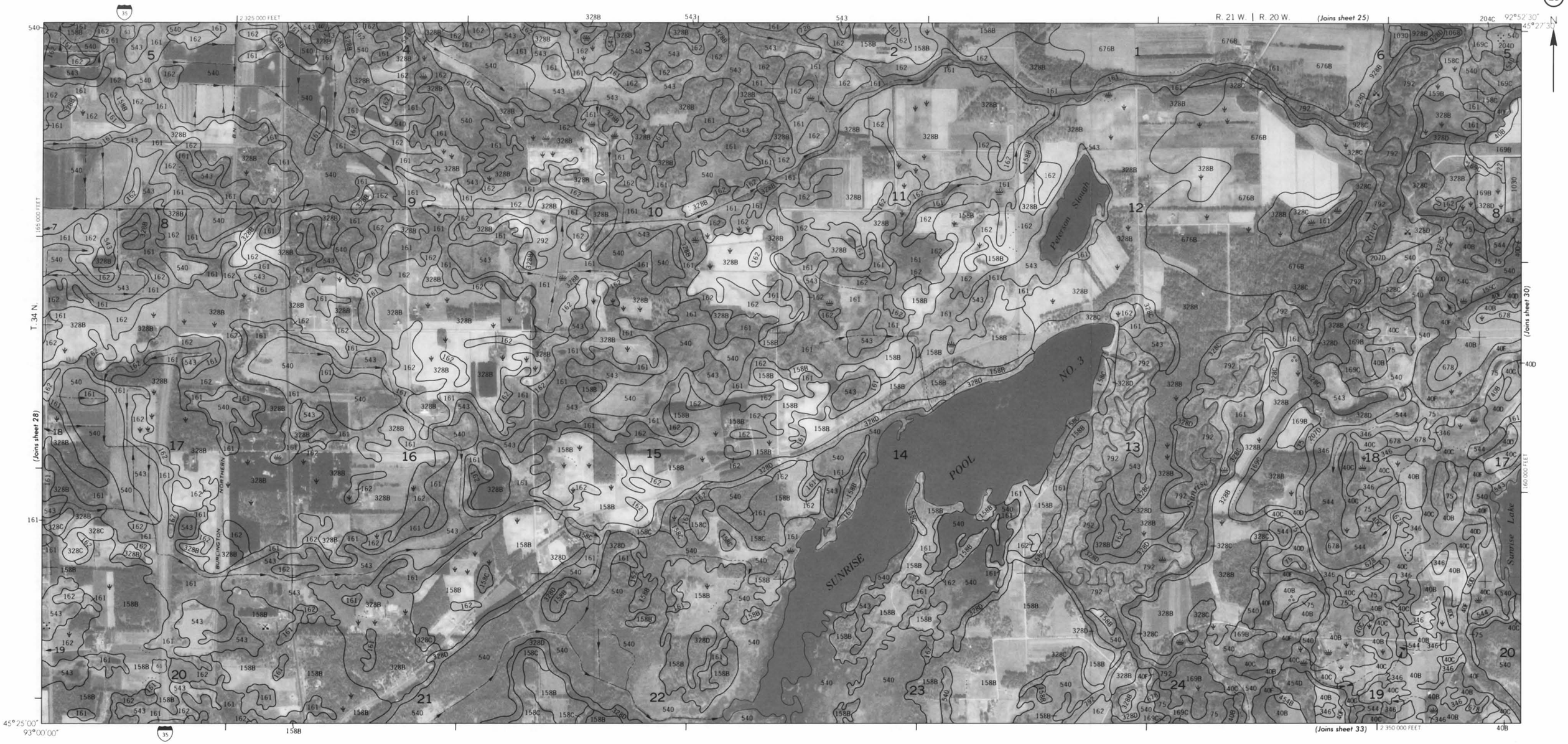

N
92°52'30"
45°30'
(Joins sheet 22)
R. 20 W.
R. 19 W.
2 380 000 FEET
185 000 FEET
(Joins sheet 25)
(Joins sheet 27)
175 000 FEET
T. 35 N.
T. 34 N.
2 355 000 FEET
(Joins sheet 30)
45°27'30"
92°45'00"
Almelund
Long Lake
Vibo Lake
Sunrise River
Dry
water
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

27
2 385 000 FEET
R. 19 W.
(Joins sheet 23)
92°37'30"
45°30'
N
185 000 FEET
ST. CROIX
POLK COUNTY
WISCONSIN
RIVER
(Joins sheet 26)
T. 35 N.
T. 34 N.
175 000 FEET
45°27'30"
92°45'00"
(Joins sheet 31)
2 415 000 FEET
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000



1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

92°52'30"
N 45°27'30"
(Joins sheet 26)
R. 20 W. | R. 19 W.
2 380 000 FEET
170 000 FEET
T. 34 N.
(Joins sheet 29)
(Joins sheet 31)
160 000 FEET
2 355 000 FEET
(Joins sheet 34)
45°25'00"
92°45'00"
Vibo Lake
SUNRISE LAKE
North Center Lake
Little Lake
1 MILE
1 KILOMETER
SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

(Joins sheet 31)
(Joins sheet 34)
(Joins sheet 39)
R. 19 W. | R. 18 W.
T. 33 N. | T. 34 N.
2 390 000 FEET
2 415 000 FEET
155 000 FEET
145 000 FEET
93° 37'30"
45° 25'
45°22'30"
93°45'00"
N
Taylors Falls
ST. CROIX RIVER
WISCONSIN
POLK COUNTY
INTERSTATE STATE PARK
Lawrence Creek
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

2 325 000 FEET
R. 21 W. | R. 20 W.
(Joins sheet 33)
92°52'30"
45°22'30"
N
CHISAGO CITY
CHISAGO LAKE
Lake Martha
Lake Ellen
Little Green Lake
GREEN LAKE
Lake Emily
Sam Lake
White Stone Lake
Sunrise River
South Branch
Sunrise River
water
WYOMING
BURLINGTON NORTHERN
T. 33 N.
135 000 FEET
125 000 FEET
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 41)
2 350 000 FEET
45°20'00"
93°00'00"
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

(Joins sheet 35)
R. 19 W.
2 390 000 FEET
92°37'30"
45°22'30"
N
140 000 FEET
T. 33 N.
(Joins sheet 38)
540
Franconia
Lawrence Creek
ST CROIX RIVER
POLK COUNTY
WISCONSIN
Johnson Lake
water
130 000 FEET
45°20'00"
92°45'00"
(Joins sheet 43)
2 415 000 FEET
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

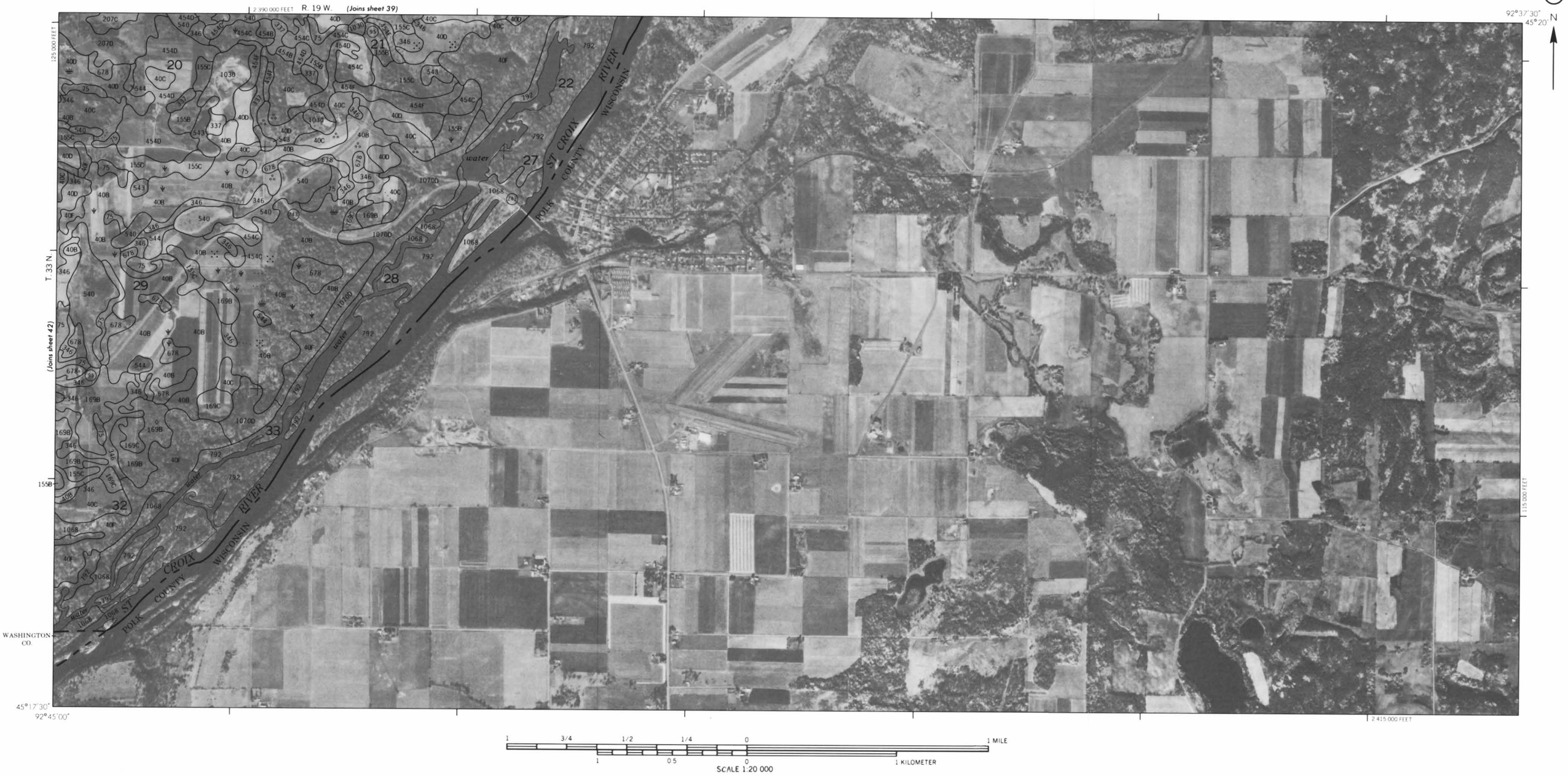
1 0.5 0 1 KILOMETER

SCALE 1:20 000

1 3/4 1/2 1/4 0 1 MILE

1 0.5 0 1 KILOMETER

SCALE 1:20 000


2 390 000 FEET
R. 19 W.
(Joins sheet 39)
92°37'30"
45°20'
N
125 000 FEET
T. 33 N.
(Joins sheet 42)
155B
WASHINGTON CO.
45°17'30"
92°45'00"
115 000 FEET
2 415 000 FEET
ST. CROIX RIVER
WISCONSIN
POLK COUNTY
water
20
21
22
27
28
29
32
33
1 3/4 1/2 1/4 0 1 MILE
1 0.5 0 1 KILOMETER
SCALE 1:20 000